

APPENDIX G

RADIATION DOSE CALCULATION METHODS AND ASSUMPTIONS

The operation of alternative cooling water systems for the K- and C-Reactors at the Savannah River Plant (SRP) would change the amount of radioactive materials released to the environment. Cooling alternatives associated with the D-Area would not cause any changes in radioactive releases to the environment. This appendix describes the methods and assumptions used to (1) determine the change in radiological impacts expected to result from the operation of the cooling alternatives, and (2) determine the doses expected from the operation of facilities on or within 80 kilometers of SRP without the implementation of cooling alternatives (no action - existing conditions).

The cooling water alternatives for K- and C-Reactors that are considered in this EIS are existing operation (no action), recirculating cooling towers, and once-through cooling towers. For the once-through alternative, doses were analyzed for gravity-flow, natural-draft cooling towers without holding ponds. For the recirculating alternative, doses were analyzed for gravity-flow, natural-draft cooling towers pumped to mechanical-draft cooling towers without holding ponds.

The implementation of a once-through or recirculating cooling-tower alternative for K- and C-Reactors would change the amount of radionuclides released to the environment. Because of an increase in evaporation from cooling towers, a greater amount of tritium would be released to the atmosphere, resulting in a positive tritium source term. However, for liquid releases the tritium source term would decrease by the same amount and, therefore, would be considered a negative value. Also, the implementation of alternative cooling water systems might cause a change in the rate of remobilization of radionuclides present in creek beds. Remobilization is discussed in Section G.2 and Appendix D.

Radioactive materials released to the environment generally become involved in a complex series of physical, chemical, and biological processes. The principal pathways by which radioactivity released from a facility can reach people are (1) exposure to nuclides in the air, in the water, or on the ground, (2) inhalation of radioactivity, and (3) ingestion of radioactivity in food and water. Figure G-1 shows these pathways.

The calculations of radiological doses to members of the public from these various pathways are based on methods recommended by the U.S. Nuclear Regulatory Commission (NRC) for licensing power reactors. However, the dose-conversion factors were taken from ICRP Publication 30 (ICRP, 1979). Estimates of doses are based on detailed analyses of the sources and rates of radioactive releases and the pathways by which people can be exposed to dispersed radioactive materials. The NRC methods are adapted to specific SRP conditions.

In the calculation of doses, the dose-conversion factors for adults presented in ICRP-30 were used. Dose factors for other age groups have not yet been published by the ICRP. However, age-specific usage factors were used to

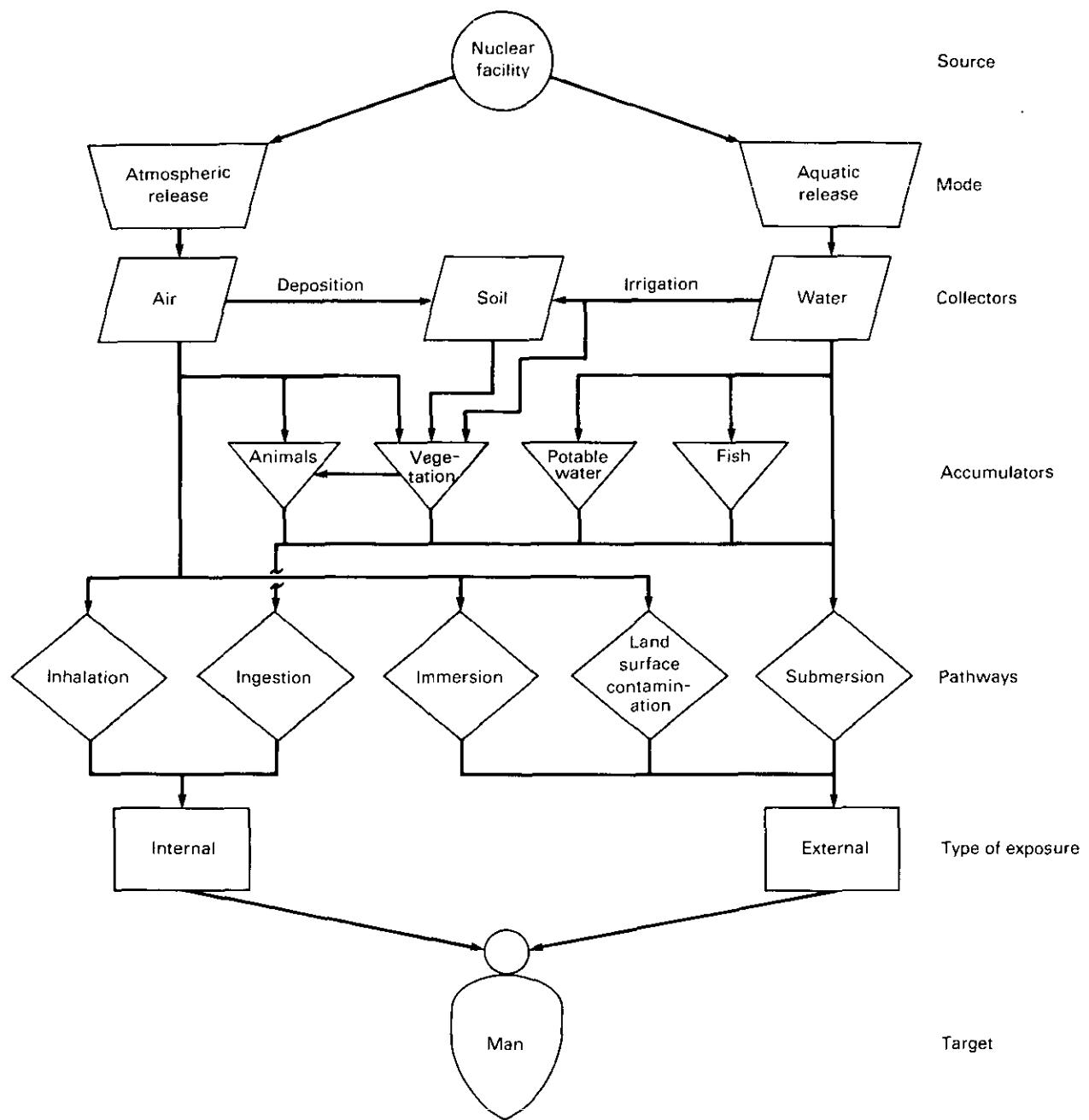


Figure G-1. Exposure Pathways Considered in Radiological Impact Assessments

calculate doses. The age groups considered were infant (0 to 1 year old), child (1 to 11 years old), teen (11-17 years old), and adult (17 years old and older).

Dose-conversion factors are provided in ICRP-30 for many organs. These factors depend on the physical and chemical nature of the radionuclide. The oral- and inhalation-dose conversion factors chosen for tritium presume it to be in the form of tritiated water. Also, to account for tritium absorption through the skin, the inhalation-dose conversion factor is increased by a factor of 0.5. For all radionuclides released to the environment, an effective-whole-body-dose conversion factor was obtained by multiplying the individual-organ-dose conversion factors by the health-risk weighting factors presented in ICRP-30 and summing the results.

Radiation doses are calculated for the maximally exposed individual. In addition, collective radiation doses are calculated for the population within 80 kilometers of the Savannah River Plant and that population served by the Beaufort-Jasper County and Cherokee Hill (Port Wentworth) water-treatment plants.

G.1 ATMOSPHERIC RELEASES

For airborne releases, annual average air concentration and ground deposition per unit release (X/Q and D/Q) were calculated for each of 160 segments (16 wind-direction sectors at 10 distances) within an 80-kilometer radius of the site and for the site boundaries, using the methods implemented in the NRC computer program X0QDOQ (Sagendorf and Goll, 1976). Site-specific meteorological data were used to generate joint-frequency distributions (JFDs) of wind speed, stability, and direction for input to X0QDOQ (Table G-1). These stability windrose statistics were derived by 1-hour averaging of data collected at the 61-meter level of the SRP H-Area meteorological tower during the 5-year period from 1975 to 1979. Stability class was determined from the observed azimuthal and vertical standard deviations (σ_θ and σ_ϕ). Values of X/Q and D/Q by compass sector and radial increment for ground-level and elevated releases (using the windspeed measured at a height of 61 meters) are presented in Tables G-2 and G-3, respectively. Flat terrain was assumed; no credit was taken for plume rise induced by momentum or thermal effects.

TC

The meteorological dispersion parameters obtained by running the X0QDOQ code are used as input to the NRC GASPAR code (Eckerman et al., 1980), which implements the radiological exposure models of Regulatory Guide 1.109, Revision 1 (NRC, 1977), to estimate doses from atmospheric exposure pathways to the effective whole body and various organs. Dose-conversion factors presented in ICRP-30 were input to the GASPAR code. Population distribution data and milk-, meat-, and vegetable-production distribution data (Table G-4) for the 16 wind-direction sectors are also used as input to GASPAR for calculating the collective dose to the regional population; the term "regional population" refers to those individuals residing within 80 kilometers of the Plant. Population data for the year 2000 are used in this analysis.

Source terms that are input to the GASPAR code and used in the calculation of doses to the maximally exposed individual and the regional population are

Table G-1. Joint-Frequency Distribution of Wind: H-Area Tower, 1975-1979

Wind speed class (m/sec)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
ATMOSPHERIC STABILITY CLASS A (VERY UNSTABLE)																	
0.0-2.0	0.39	0.32	0.39	0.33	0.32	0.38	0.41	0.40	0.37	0.36	0.40	0.40	0.56	0.61	0.46	0.39	6.49
2.1-4.0	0.31	0.28	0.31	0.42	0.59	0.64	0.68	0.48	0.48	0.45	0.49	0.44	0.56	0.63	0.53	0.34	7.62
4.1-6.0	0.04	0.05	0.05	0.08	0.18	0.15	0.08	0.08	0.09	0.13	0.17	0.12	0.09	0.09	0.14	0.08	1.64
6.1-8.0	0.01	0.00	0.01	0.01	0.03	0.01	0.01	0.00	0.06	0.06	0.01	0.02	0.03	0.02	0.03	0.01	0.31
8.1-12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.09
12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATMOSPHERIC STABILITY CLASS B (UNSTABLE)																	
0.0-2.0	0.09	0.10	0.17	0.13	0.17	0.18	0.14	0.11	0.15	0.11	0.11	0.22	0.22	0.23	0.19	0.13	2.46
2.1-4.0	0.19	0.14	0.27	0.39	0.38	0.41	0.36	0.26	0.29	0.26	0.29	0.29	0.37	0.44	0.31	0.28	4.92
4.1-6.0	0.05	0.05	0.07	0.26	0.27	0.21	0.13	0.12	0.21	0.24	0.18	0.17	0.16	0.28	0.27	0.18	2.85
6.1-8.0	0.02	0.02	0.01	0.04	0.03	0.02	0.00	0.03	0.06	0.05	0.03	0.04	0.05	0.02	0.07	0.03	0.53
8.1-12.0	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.02	0.02	0.01	0.08
12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATMOSPHERIC STABILITY CLASS C (SLIGHTLY UNSTABLE)																	
0.0-2.0	0.12	0.11	0.21	0.19	0.18	0.17	0.16	0.13	0.14	0.16	0.16	0.13	0.25	0.29	0.15	0.18	2.75
2.1-4.0	0.20	0.19	0.39	0.62	0.69	0.58	0.45	0.47	0.29	0.36	0.40	0.38	0.66	0.60	0.49	0.35	7.11
4.1-6.0	0.11	0.10	0.18	0.50	0.55	0.46	0.23	0.24	0.37	0.44	0.32	0.42	0.47	0.49	0.46	0.23	5.58
6.1-8.0	0.01	0.02	0.04	0.18	0.14	0.02	0.06	0.08	0.07	0.11	0.11	0.15	0.18	0.18	0.37	0.19	1.92
8.1-12.0	0.01	0.01	0.01	0.01	0.02	0.00	0.00	0.03	0.01	0.02	0.05	0.03	0.10	0.11	0.26	0.09	0.76
12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.02	0.02
ATMOSPHERIC STABILITY CLASS D (NEUTRAL)																	
0.0-2.0	0.11	0.10	0.17	0.18	0.17	0.14	0.18	0.18	0.17	0.17	0.16	0.23	0.31	0.32	0.22	0.15	2.98
2.1-4.0	0.31	0.34	0.58	0.79	1.02	0.98	0.66	0.70	0.51	0.49	0.82	0.68	0.79	0.88	0.77	0.54	10.87
4.1-6.0	0.16	0.16	0.33	0.82	0.78	0.68	0.57	0.62	0.62	0.93	0.73	0.73	0.83	1.14	1.22	0.41	10.73
6.1-8.0	0.06	0.04	0.06	0.15	0.08	0.06	0.12	0.17	0.20	0.23	0.23	0.27	0.36	0.50	0.83	0.21	3.56
8.1-12.0	0.00	0.00	0.01	0.01	0.00	0.00	0.01	0.02	0.04	0.05	0.08	0.08	0.24	0.37	0.47	0.15	1.53
12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.05	0.02	0.00	0.11	0.11

Table G-1. Joint-Frequency Distribution of Wind: H-Area Tower, 1975-1979 (continued)

Wind speed class (m/sec)	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
ATMOSPHERIC STABILITY CLASS E (SLIGHTLY STABLE)																	
0.0-2.0	0.05	0.10	0.16	0.06	0.09	0.06	0.15	0.08	0.19	0.08	0.12	0.16	0.18	0.14	0.11	0.09	1.81
2.1-4.0	0.26	0.28	0.43	0.27	0.56	0.38	0.67	0.45	0.41	0.27	0.63	0.63	0.58	0.43	0.51	0.38	7.13
4.1-6.0	0.21	0.19	0.37	0.69	0.58	0.55	0.65	0.64	0.65	0.80	0.92	0.74	0.86	0.84	0.57	0.37	9.64
6.1-8.0	0.01	0.01	0.09	0.06	0.03	0.05	0.10	0.03	0.08	0.15	0.14	0.13	0.14	0.08	0.03	0.02	1.16
8.1-12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.03
12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATMOSPHERIC STABILITY CLASS F (STABLE)																	
0.0-2.0	0.03	0.01	0.03	0.02	0.02	0.03	0.03	0.02	0.03	0.02	0.02	0.01	0.02	0.01	0.00	0.01	0.30
2.1-4.0	0.15	0.08	0.11	0.02	0.10	0.03	0.22	0.09	0.08	0.05	0.09	0.09	0.10	0.12	0.03	0.07	1.44
4.1-6.0	0.13	0.15	0.24	0.30	0.22	0.08	0.23	0.13	0.14	0.06	0.16	0.14	0.16	0.18	0.05	0.05	2.42
6.1-8.0	0.01	0.00	0.03	0.03	0.01	0.01	0.03	0.02	0.02	0.02	0.04	0.00	0.03	0.02	0.00	0.01	0.29
8.1-12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ATMOSPHERIC STABILITY CLASS G (VERY STABLE)																	
0.0-2.0	0.00	0.01	0.01	0.00	0.01	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.14
2.1-4.0	0.00	0.07	0.26	0.01	0.01	0.01	0.10	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.50
4.1-6.0	0.00	0.00	0.07	0.01	0.00	0.01	0.03	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.18
6.1-8.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
8.1-12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ALL CLASSES																	
All classes	3.06	2.94	5.08	6.57	7.23	6.31	6.52	5.62	5.77	6.08	6.90	6.76	8.42	9.15	8.59	4.97	

Table G-2. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Ground-Level Releases

Direction from site	Distance (km)									
	0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
ANNUAL AVERAGE X/Q, UNDECAYED AND UNDEPLETED (sec/m ³)										
N	8.254 x 10 ⁻⁷	2.524 x 10 ⁻⁷	1.084 x 10 ⁻⁷	6.403 x 10 ⁻⁸	4.365 x 10 ⁻⁸	2.117 x 10 ⁻⁸	7.908 x 10 ⁻⁹	3.881 x 10 ⁻⁹	2.468 x 10 ⁻⁹	1.769 x 10 ⁻⁹
NNE	7.390 x 10 ⁻⁷	2.245 x 10 ⁻⁷	9.554 x 10 ⁻⁸	5.606 x 10 ⁻⁸	3.802 x 10 ⁻⁸	1.827 x 10 ⁻⁸	6.741 x 10 ⁻⁹	3.291 x 10 ⁻⁹	2.089 x 10 ⁻⁹	1.495 x 10 ⁻⁹
NE	9.494 x 10 ⁻⁷	2.912 x 10 ⁻⁷	1.251 x 10 ⁻⁷	7.389 x 10 ⁻⁸	5.035 x 10 ⁻⁸	2.434 x 10 ⁻⁸	9.042 x 10 ⁻⁹	4.417 x 10 ⁻⁹	2.800 x 10 ⁻⁹	2.002 x 10 ⁻⁹
ENE	9.499 x 10 ⁻⁷	2.902 x 10 ⁻⁷	1.241 x 10 ⁻⁷	7.304 x 10 ⁻⁸	4.966 x 10 ⁻⁸	2.397 x 10 ⁻⁸	8.882 x 10 ⁻⁹	4.330 x 10 ⁻⁹	2.742 x 10 ⁻⁹	1.959 x 10 ⁻⁹
E	1.227 x 10 ⁻⁶	3.746 x 10 ⁻⁷	1.605 x 10 ⁻⁷	9.473 x 10 ⁻⁸	6.453 x 10 ⁻⁸	3.125 x 10 ⁻⁸	1.167 x 10 ⁻⁸	5.747 x 10 ⁻⁹	3.666 x 10 ⁻⁹	2.634 x 10 ⁻⁹
ESE	1.156 x 10 ⁻⁶	3.503 x 10 ⁻⁷	1.486 x 10 ⁻⁷	8.699 x 10 ⁻⁸	5.889 x 10 ⁻⁸	2.824 x 10 ⁻⁸	1.039 x 10 ⁻⁸	5.068 x 10 ⁻⁹	3.216 x 10 ⁻⁹	2.302 x 10 ⁻⁹
SE	9.465 x 10 ⁻⁷	2.866 x 10 ⁻⁷	1.213 x 10 ⁻⁷	7.079 x 10 ⁻⁸	4.781 x 10 ⁻⁸	2.282 x 10 ⁻⁸	8.327 x 10 ⁻⁹	4.029 x 10 ⁻⁹	2.544 x 10 ⁻⁹	1.814 x 10 ⁻⁹
SSE	6.359 x 10 ⁻⁷	1.918 x 10 ⁻⁷	8.127 x 10 ⁻⁸	4.757 x 10 ⁻⁸	3.221 x 10 ⁻⁸	1.548 x 10 ⁻⁸	5.727 x 10 ⁻⁹	2.813 x 10 ⁻⁹	1.793 x 10 ⁻⁹	1.288 x 10 ⁻⁹
S	4.705 x 10 ⁻⁷	1.433 x 10 ⁻⁷	6.196 x 10 ⁻⁸	3.681 x 10 ⁻⁸	2.522 x 10 ⁻⁸	1.236 x 10 ⁻⁸	4.709 x 10 ⁻⁹	2.353 x 10 ⁻⁹	1.515 x 10 ⁻⁹	1.095 x 10 ⁻⁹
SSW	5.057 x 10 ⁻⁷	1.551 x 10 ⁻⁷	6.730 x 10 ⁻⁸	4.009 x 10 ⁻⁸	2.752 x 10 ⁻⁸	1.351 x 10 ⁻⁸	5.156 x 10 ⁻⁹	2.576 x 10 ⁻⁹	1.656 x 10 ⁻⁹	1.197 x 10 ⁻⁹
SW	9.776 x 10 ⁻⁷	3.013 x 10 ⁻⁷	1.313 x 10 ⁻⁷	7.850 x 10 ⁻⁸	5.404 x 10 ⁻⁸	2.666 x 10 ⁻⁸	1.025 x 10 ⁻⁸	5.149 x 10 ⁻⁹	3.322 x 10 ⁻⁹	2.407 x 10 ⁻⁹
WSW	8.207 x 10 ⁻⁷	2.479 x 10 ⁻⁷	1.048 x 10 ⁻⁷	6.127 x 10 ⁻⁸	4.144 x 10 ⁻⁸	1.984 x 10 ⁻⁸	7.307 x 10 ⁻⁹	3.576 x 10 ⁻⁹	2.276 x 10 ⁻⁹	1.632 x 10 ⁻⁹
W	9.536 x 10 ⁻⁷	2.893 x 10 ⁻⁷	1.230 x 10 ⁻⁷	7.213 x 10 ⁻⁸	4.892 x 10 ⁻⁸	2.354 x 10 ⁻⁸	8.718 x 10 ⁻⁹	4.276 x 10 ⁻⁹	2.722 x 10 ⁻⁹	1.953 x 10 ⁻⁹
WNW	7.890 x 10 ⁻⁷	2.378 x 10 ⁻⁷	1.007 x 10 ⁻⁷	5.889 x 10 ⁻⁸	3.987 x 10 ⁻⁸	1.917 x 10 ⁻⁸	7.106 x 10 ⁻⁹	3.494 x 10 ⁻⁹	2.229 x 10 ⁻⁹	1.603 x 10 ⁻⁹
NW	1.103 x 10 ⁻⁶	3.407 x 10 ⁻⁷	1.484 x 10 ⁻⁷	8.866 x 10 ⁻⁸	6.096 x 10 ⁻⁸	2.997 x 10 ⁻⁸	1.144 x 10 ⁻⁸	5.699 x 10 ⁻⁹	3.657 x 10 ⁻⁹	2.638 x 10 ⁻⁹
NNW	7.672 x 10 ⁻⁷	2.342 x 10 ⁻⁷	1.003 x 10 ⁻⁷	5.907 x 10 ⁻⁸	4.019 x 10 ⁻⁸	1.939 x 10 ⁻⁸	7.193 x 10 ⁻⁹	3.517 x 10 ⁻⁹	2.233 x 10 ⁻⁹	1.598 x 10 ⁻⁹
ANNUAL AVERAGE X/Q, DECAYED AND UNDEPLETED (sec/m ³)										
N	8.235 x 10 ⁻⁷	2.513 x 10 ⁻⁷	1.076 x 10 ⁻⁷	6.334 x 10 ⁻⁸	4.304 x 10 ⁻⁸	2.070 x 10 ⁻⁸	7.557 x 10 ⁻⁹	3.592 x 10 ⁻⁹	2.214 x 10 ⁻⁹	1.538 x 10 ⁻⁹
NNE	7.375 x 10 ⁻⁷	2.236 x 10 ⁻⁷	9.490 x 10 ⁻⁸	5.553 x 10 ⁻⁸	3.756 x 10 ⁻⁸	1.791 x 10 ⁻⁸	6.477 x 10 ⁻⁹	3.073 x 10 ⁻⁹	1.896 x 10 ⁻⁹	1.320 x 10 ⁻⁹
NE	9.476 x 10 ⁻⁷	2.901 x 10 ⁻⁷	1.243 x 10 ⁻⁷	7.322 x 10 ⁻⁸	4.976 x 10 ⁻⁸	2.388 x 10 ⁻⁸	8.701 x 10 ⁻⁹	4.135 x 10 ⁻⁹	2.552 x 10 ⁻⁹	1.776 x 10 ⁻⁹
ENE	9.479 x 10 ⁻⁷	2.890 x 10 ⁻⁷	1.232 x 10 ⁻⁷	7.231 x 10 ⁻⁸	4.902 x 10 ⁻⁸	2.347 x 10 ⁻⁸	8.514 x 10 ⁻⁹	4.028 x 10 ⁻⁹	2.477 x 10 ⁻⁹	1.719 x 10 ⁻⁹
E	1.224 x 10 ⁻⁶	3.729 x 10 ⁻⁷	1.593 x 10 ⁻⁷	9.367 x 10 ⁻⁸	6.361 x 10 ⁻⁸	3.052 x 10 ⁻⁸	1.113 x 10 ⁻⁸	5.297 x 10 ⁻⁹	3.268 x 10 ⁻⁹	2.271 x 10 ⁻⁹
ESE	1.154 x 10 ⁻⁶	3.488 x 10 ⁻⁷	1.476 x 10 ⁻⁷	8.613 x 10 ⁻⁸	5.815 x 10 ⁻⁸	2.766 x 10 ⁻⁸	9.970 x 10 ⁻⁹	4.721 x 10 ⁻⁹	2.909 x 10 ⁻⁹	2.023 x 10 ⁻⁹
SE	9.447 x 10 ⁻⁷	2.856 x 10 ⁻⁷	1.205 x 10 ⁻⁷	7.014 x 10 ⁻⁸	4.725 x 10 ⁻⁸	2.238 x 10 ⁻⁸	8.005 x 10 ⁻⁹	3.764 x 10 ⁻⁹	2.310 x 10 ⁻⁹	1.602 x 10 ⁻⁹

Table G-2. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Ground-Level Releases (continued)

Direction from site	Distance (km)									
	0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
ANNUAL AVERAGE X/Q, DECAYED AND UNDEPLETED (sec/m ³) (continued)										
SSE	6.345 x 10 ⁻⁷	1.910 x 10 ⁻⁷	8.068 x 10 ⁻⁸	4.708 x 10 ⁻⁸	3.179 x 10 ⁻⁸	1.515 x 10 ⁻⁸	5.484 x 10 ⁻⁹	2.611 x 10 ⁻⁹	1.615 x 10 ⁻⁹	1.125 x 10 ⁻⁹
S	4.694 x 10 ⁻⁷	1.427 x 10 ⁻⁷	6.148 x 10 ⁻⁸	3.641 x 10 ⁻⁸	2.487 x 10 ⁻⁸	1.208 x 10 ⁻⁸	4.497 x 10 ⁻⁹	2.175 x 10 ⁻⁹	1.355 x 10 ⁻⁹	9.491 x 10 ⁻¹⁰
SSW	5.045 x 10 ⁻⁷	1.544 x 10 ⁻⁷	6.677 x 10 ⁻⁸	3.965 x 10 ⁻⁸	2.713 x 10 ⁻⁸	1.321 x 10 ⁻⁸	4.925 x 10 ⁻⁹	2.382 x 10 ⁻⁹	1.484 x 10 ⁻⁹	1.039 x 10 ⁻⁹
SW	9.755 x 10 ⁻⁷	2.999 x 10 ⁻⁷	1.303 x 10 ⁻⁷	7.768 x 10 ⁻⁸	5.332 x 10 ⁻⁸	2.609 x 10 ⁻⁸	9.816 x 10 ⁻⁹	4.786 x 10 ⁻⁹	2.999 x 10 ⁻⁹	2.110 x 10 ⁻⁹
WSW	8.191 x 10 ⁻⁷	2.470 x 10 ⁻⁷	1.042 x 10 ⁻⁷	6.072 x 10 ⁻⁸	4.096 x 10 ⁻⁸	1.948 x 10 ⁻⁸	7.038 x 10 ⁻⁹	3.355 x 10 ⁻⁹	2.080 x 10 ⁻⁹	1.454 x 10 ⁻⁹
W	9.518 x 10 ⁻⁷	2.882 x 10 ⁻⁷	1.221 x 10 ⁻⁷	7.145 x 10 ⁻⁸	4.833 x 10 ⁻⁸	2.308 x 10 ⁻⁸	8.379 x 10 ⁻⁹	3.996 x 10 ⁻⁹	2.475 x 10 ⁻⁹	1.727 x 10 ⁻⁹
WNW	7.874 x 10 ⁻⁷	2.368 x 10 ⁻⁷	9.997 x 10 ⁻⁸	5.832 x 10 ⁻⁸	3.937 x 10 ⁻⁸	1.879 x 10 ⁻⁸	6.819 x 10 ⁻⁹	3.255 x 10 ⁻⁹	2.017 x 10 ⁻⁹	1.408 x 10 ⁻⁹
NW	1.101 x 10 ⁻⁶	3.392 x 10 ⁻⁷	1.474 x 10 ⁻⁷	8.774 x 10 ⁻⁸	6.015 x 10 ⁻⁸	2.932 x 10 ⁻⁸	1.094 x 10 ⁻⁸	5.287 x 10 ⁻⁹	3.291 x 10 ⁻⁹	2.303 x 10 ⁻⁹
NNW	7.657 x 10 ⁻⁷	2.332 x 10 ⁻⁷	9.959 x 10 ⁻⁸	5.851 x 10 ⁻⁸	3.969 x 10 ⁻⁸	1.901 x 10 ⁻⁸	6.910 x 10 ⁻⁹	3.283 x 10 ⁻⁹	2.027 x 10 ⁻⁹	1.411 x 10 ⁻⁹
ANNUAL AVERAGE X/Q, DECAYED AND DEPLETED (sec/m ³)										
N	7.396 x 10 ⁻⁷	2.154 x 10 ⁻⁷	8.784 x 10 ⁻⁸	4.988 x 10 ⁻⁸	3.290 x 10 ⁻⁸	1.496 x 10 ⁻⁸	4.918 x 10 ⁻⁹	2.112 x 10 ⁻⁹	1.212 x 10 ⁻⁹	7.949 x 10 ⁻¹⁰
NNE	6.623 x 10 ⁻⁷	1.916 x 10 ⁻⁷	7.745 x 10 ⁻⁸	4.369 x 10 ⁻⁸	2.868 x 10 ⁻⁸	1.293 x 10 ⁻⁸	4.200 x 10 ⁻⁹	1.795 x 10 ⁻⁹	1.029 x 10 ⁻⁹	6.749 x 10 ⁻¹⁰
NE	8.508 x 10 ⁻⁷	2.485 x 10 ⁻⁷	1.014 x 10 ⁻⁷	5.759 x 10 ⁻⁸	3.798 x 10 ⁻⁸	1.723 x 10 ⁻⁸	5.635 x 10 ⁻⁹	2.411 x 10 ⁻⁹	1.381 x 10 ⁻⁹	9.050 x 10 ⁻¹⁰
ENE	8.512 x 10 ⁻⁷	2.476 x 10 ⁻⁷	1.006 x 10 ⁻⁷	5.692 x 10 ⁻⁸	3.744 x 10 ⁻⁸	1.695 x 10 ⁻⁸	5.530 x 10 ⁻⁹	2.360 x 10 ⁻⁹	1.349 x 10 ⁻⁹	8.827 x 10 ⁻¹⁰
E	1.100 x 10 ⁻⁶	3.196 x 10 ⁻⁷	1.301 x 10 ⁻⁷	7.379 x 10 ⁻⁸	4.864 x 10 ⁻⁸	2.208 x 10 ⁻⁸	7.253 x 10 ⁻⁹	3.124 x 10 ⁻⁹	1.796 x 10 ⁻⁹	1.181 x 10 ⁻⁹
ESE	1.036 x 10 ⁻⁶	2.990 x 10 ⁻⁷	1.204 x 10 ⁻⁷	6.779 x 10 ⁻⁸	4.441 x 10 ⁻⁸	1.997 x 10 ⁻⁸	6.472 x 10 ⁻⁹	2.763 x 10 ⁻⁹	1.583 x 10 ⁻⁹	1.038 x 10 ⁻⁹
SE	8.483 x 10 ⁻⁷	2.447 x 10 ⁻⁷	9.830 x 10 ⁻⁸	5.518 x 10 ⁻⁸	3.607 x 10 ⁻⁸	1.615 x 10 ⁻⁸	5.190 x 10 ⁻⁹	2.199 x 10 ⁻⁹	1.253 x 10 ⁻⁹	8.190 x 10 ⁻¹⁰
SSE	5.699 x 10 ⁻⁷	1.637 x 10 ⁻⁷	6.587 x 10 ⁻⁸	3.706 x 10 ⁻⁸	2.429 x 10 ⁻⁸	1.094 x 10 ⁻⁸	3.564 x 10 ⁻⁹	1.532 x 10 ⁻⁹	8.813 x 10 ⁻¹⁰	5.798 x 10 ⁻¹⁰
S	4.216 x 10 ⁻⁷	1.223 x 10 ⁻⁷	5.021 x 10 ⁻⁸	2.868 x 10 ⁻⁸	1.901 x 10 ⁻⁸	8.734 x 10 ⁻⁹	2.926 x 10 ⁻⁹	1.280 x 10 ⁻⁹	7.429 x 10 ⁻¹⁰	4.918 x 10 ⁻¹⁰
SSW	4.532 x 10 ⁻⁷	1.323 x 10 ⁻⁷	5.453 x 10 ⁻⁸	3.123 x 10 ⁻⁸	2.074 x 10 ⁻⁸	9.548 x 10 ⁻⁹	3.205 x 10 ⁻⁹	1.401 x 10 ⁻⁹	8.128 x 10 ⁻¹⁰	5.378 x 10 ⁻¹⁰
SW	8.761 x 10 ⁻⁷	2.570 x 10 ⁻⁷	1.064 x 10 ⁻⁷	6.115 x 10 ⁻⁸	4.074 x 10 ⁻⁸	1.884 x 10 ⁻⁸	6.374 x 10 ⁻⁹	2.805 x 10 ⁻⁹	1.634 x 10 ⁻⁹	1.084 x 10 ⁻⁹
WSW	7.355 x 10 ⁻⁷	2.116 x 10 ⁻⁷	8.499 x 10 ⁻⁸	4.776 x 10 ⁻⁸	3.126 x 10 ⁻⁸	1.405 x 10 ⁻⁸	4.555 x 10 ⁻⁹	1.953 x 10 ⁻⁹	1.123 x 10 ⁻⁹	7.387 x 10 ⁻¹⁰
W	8.547 x 10 ⁻⁷	2.469 x 10 ⁻⁷	9.967 x 10 ⁻⁸	5.621 x 10 ⁻⁸	3.690 x 10 ⁻⁸	1.665 x 10 ⁻⁸	5.431 x 10 ⁻⁹	2.333 x 10 ⁻⁹	1.341 x 10 ⁻⁹	8.821 x 10 ⁻¹⁰
WNW	7.071 x 10 ⁻⁷	2.030 x 10 ⁻⁷	8.159 x 10 ⁻⁸	4.589 x 10 ⁻⁸	3.007 x 10 ⁻⁸	1.356 x 10 ⁻⁸	4.425 x 10 ⁻⁹	1.905 x 10 ⁻⁹	1.097 x 10 ⁻⁹	7.225 x 10 ⁻¹⁰
NW	9.889 x 10 ⁻⁷	2.907 x 10 ⁻⁷	1.203 x 10 ⁻⁷	6.907 x 10 ⁻⁸	4.596 x 10 ⁻⁸	2.118 x 10 ⁻⁸	7.111 x 10 ⁻⁹	3.103 x 10 ⁻⁹	1.797 x 10 ⁻⁹	1.187 x 10 ⁻⁹
NNW	6.876 x 10 ⁻⁷	1.999 x 10 ⁻⁷	8.127 x 10 ⁻⁸	4.604 x 10 ⁻⁸	3.031 x 10 ⁻⁸	1.372 x 10 ⁻⁸	4.481 x 10 ⁻⁹	1.919 x 10 ⁻⁹	1.100 x 10 ⁻⁹	7.215 x 10 ⁻¹⁰

Table G-2. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Ground-Level Releases (continued)

Direction from site	Distance (km)									
	0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
ANNUAL AVERAGE D/Q (m^{-2})										
N	6.024×10^{-9}	1.861×10^{-9}	7.406×10^{-10}	4.047×10^{-10}	2.572×10^{-10}	1.105×10^{-10}	3.426×10^{-11}	1.358×10^{-11}	7.251×10^{-12}	4.488×10^{-12}
NNE	6.351×10^{-9}	1.962×10^{-9}	7.808×10^{-10}	4.267×10^{-10}	2.712×10^{-10}	1.165×10^{-10}	3.612×10^{-11}	1.432×10^{-11}	7.645×10^{-12}	4.732×10^{-12}
NE	7.209×10^{-9}	2.227×10^{-9}	8.863×10^{-10}	4.843×10^{-10}	3.078×10^{-10}	1.322×10^{-10}	4.100×10^{-11}	1.625×10^{-11}	8.678×10^{-12}	5.371×10^{-12}
ENE	7.064×10^{-9}	2.182×10^{-9}	8.684×10^{-10}	4.746×10^{-10}	3.016×10^{-10}	1.296×10^{-10}	4.017×10^{-11}	1.592×10^{-11}	8.503×10^{-12}	5.263×10^{-12}
E	8.791×10^{-9}	2.716×10^{-9}	1.081×10^{-9}	5.906×10^{-10}	3.754×10^{-10}	1.612×10^{-10}	5.000×10^{-11}	1.982×10^{-11}	1.058×10^{-11}	6.550×10^{-12}
ESE	9.561×10^{-9}	2.954×10^{-9}	1.175×10^{-9}	6.423×10^{-10}	4.083×10^{-10}	1.754×10^{-10}	5.438×10^{-11}	2.155×10^{-11}	1.151×10^{-11}	7.124×10^{-12}
SE	8.976×10^{-9}	2.773×10^{-9}	1.104×10^{-9}	6.030×10^{-10}	3.833×10^{-10}	1.646×10^{-10}	5.105×10^{-11}	2.023×10^{-11}	1.080×10^{-11}	6.688×10^{-12}
SSE	5.195×10^{-9}	1.605×10^{-9}	6.387×10^{-10}	3.490×10^{-10}	2.218×10^{-10}	9.528×10^{-11}	2.955×10^{-11}	1.171×10^{-11}	6.254×10^{-12}	3.871×10^{-12}
S	3.199×10^{-9}	9.884×10^{-10}	3.933×10^{-10}	2.149×10^{-10}	1.366×10^{-10}	5.868×10^{-11}	1.820×10^{-11}	7.212×10^{-12}	3.851×10^{-12}	2.384×10^{-12}
SSW	3.072×10^{-9}	9.491×10^{-10}	3.777×10^{-10}	2.064×10^{-10}	1.312×10^{-10}	5.634×10^{-11}	1.747×10^{-11}	6.925×10^{-12}	3.698×10^{-12}	2.289×10^{-12}
SW	5.308×10^{-9}	1.640×10^{-9}	6.525×10^{-10}	3.566×10^{-10}	2.266×10^{-10}	9.735×10^{-11}	3.019×10^{-11}	1.196×10^{-11}	6.389×10^{-12}	3.955×10^{-12}
WSW	6.867×10^{-9}	2.122×10^{-9}	8.443×10^{-10}	4.614×10^{-10}	2.932×10^{-10}	1.260×10^{-10}	3.906×10^{-11}	1.548×10^{-11}	8.267×10^{-12}	5.117×10^{-12}
W	7.555×10^{-9}	2.334×10^{-9}	9.288×10^{-10}	5.075×10^{-10}	3.226×10^{-10}	1.386×10^{-10}	4.297×10^{-11}	1.703×10^{-11}	9.094×10^{-12}	5.629×10^{-12}
WNW	6.595×10^{-9}	2.037×10^{-9}	8.108×10^{-10}	4.430×10^{-10}	2.816×10^{-10}	1.210×10^{-10}	3.751×10^{-11}	1.487×10^{-11}	7.938×10^{-12}	4.914×10^{-12}
NW	6.813×10^{-9}	2.105×10^{-9}	8.376×10^{-10}	4.577×10^{-10}	2.909×10^{-10}	1.250×10^{-10}	3.875×10^{-11}	1.536×10^{-11}	8.201×10^{-12}	5.076×10^{-12}
NNW	5.875×10^{-9}	1.815×10^{-9}	7.223×10^{-10}	3.947×10^{-10}	2.509×10^{-10}	1.078×10^{-10}	3.341×10^{-11}	1.324×10^{-11}	7.072×10^{-12}	4.377×10^{-12}

Table G-3. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Elevated Releases

Direction from site	Distance (km)									
	0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
ANNUAL AVERAGE X/Q, UNDECAYED AND UNDEPLETED (sec/m ³)										
N	1.657 x 10 ⁻⁷	9.830 x 10 ⁻⁸	6.035 x 10 ⁻⁸	4.110 x 10 ⁻⁸	3.030 x 10 ⁻⁸	1.617 x 10 ⁻⁸	6.688 x 10 ⁻⁹	3.455 x 10 ⁻⁹	2.246 x 10 ⁻⁹	1.630 x 10 ⁻⁹
NNE	1.715 x 10 ⁻⁷	9.824 x 10 ⁻⁸	5.792 x 10 ⁻⁸	3.855 x 10 ⁻⁸	2.800 x 10 ⁻⁸	1.461 x 10 ⁻⁸	5.878 x 10 ⁻⁹	2.997 x 10 ⁻⁹	1.938 x 10 ⁻⁹	1.402 x 10 ⁻⁹
NE	1.851 x 10 ⁻⁷	1.140 x 10 ⁻⁷	7.034 x 10 ⁻⁸	4.786 x 10 ⁻⁸	3.523 x 10 ⁻⁸	1.870 x 10 ⁻⁸	7.660 x 10 ⁻⁹	3.931 x 10 ⁻⁹	2.546 x 10 ⁻⁹	1.843 x 10 ⁻⁹
ENE	1.979 x 10 ⁻⁷	1.186 x 10 ⁻⁷	7.223 x 10 ⁻⁸	4.881 x 10 ⁻⁸	3.578 x 10 ⁻⁸	1.891 x 10 ⁻⁸	7.703 x 10 ⁻⁹	3.936 x 10 ⁻⁹	2.542 x 10 ⁻⁹	1.837 x 10 ⁻⁹
E	2.592 x 10 ⁻⁷	1.492 x 10 ⁻⁷	8.848 x 10 ⁻⁸	5.922 x 10 ⁻⁸	4.323 x 10 ⁻⁸	2.278 x 10 ⁻⁸	9.331 x 10 ⁻⁸	4.829 x 10 ⁻⁹	3.150 x 10 ⁻⁹	2.294 x 10 ⁻⁹
ESE	2.821 x 10 ⁻⁷	1.583 x 10 ⁻⁷	9.177 x 10 ⁻⁸	6.061 x 10 ⁻⁸	4.382 x 10 ⁻⁸	2.274 x 10 ⁻⁸	9.098 x 10 ⁻⁸	4.628 x 10 ⁻⁹	2.990 x 10 ⁻⁹	2.162 x 10 ⁻⁹
SE	2.365 x 10 ⁻⁷	1.357 x 10 ⁻⁷	7.860 x 10 ⁻⁸	5.161 x 10 ⁻⁸	3.711 x 10 ⁻⁸	1.904 x 10 ⁻⁸	7.490 x 10 ⁻⁹	3.757 x 10 ⁻⁹	2.407 x 10 ⁻⁹	1.731 x 10 ⁻⁹
SSE	1.609 x 10 ⁻⁷	8.715 x 10 ⁻⁸	5.018 x 10 ⁻⁸	3.311 x 10 ⁻⁸	2.394 x 10 ⁻⁸	1.246 x 10 ⁻⁸	5.017 x 10 ⁻⁹	2.571 x 10 ⁻⁹	1.669 x 10 ⁻⁹	1.212 x 10 ⁻⁹
S	9.942 x 10 ⁻⁸	5.287 x 10 ⁻⁸	3.174 x 10 ⁻⁸	2.172 x 10 ⁻⁸	1.615 x 10 ⁻⁸	8.804 x 10 ⁻⁹	3.772 x 10 ⁻⁹	2.007 x 10 ⁻⁹	1.329 x 10 ⁻⁹	9.773 x 10 ⁻¹⁰
SSW	9.513 x 10 ⁻⁸	5.374 x 10 ⁻⁸	3.282 x 10 ⁻⁸	2.247 x 10 ⁻⁸	1.669 x 10 ⁻⁸	9.063 x 10 ⁻⁹	3.867 x 10 ⁻⁹	2.055 x 10 ⁻⁹	1.360 x 10 ⁻⁹	1.000 x 10 ⁻⁹
SW	1.629 x 10 ⁻⁷	9.250 x 10 ⁻⁸	5.601 x 10 ⁻⁸	3.832 x 10 ⁻⁸	2.850 x 10 ⁻⁸	1.560 x 10 ⁻⁸	6.776 x 10 ⁻⁹	3.661 x 10 ⁻⁹	2.449 x 10 ⁻⁹	1.815 x 10 ⁻⁹
WSW	2.038 x 10 ⁻⁷	1.107 x 10 ⁻⁷	6.305 x 10 ⁻⁸	4.144 x 10 ⁻⁸	2.991 x 10 ⁻⁸	1.553 x 10 ⁻⁸	6.242 x 10 ⁻⁹	3.200 x 10 ⁻⁹	2.078 x 10 ⁻⁹	1.508 x 10 ⁻⁹
W	2.212 x 10 ⁻⁷	1.229 x 10 ⁻⁷	7.136 x 10 ⁻⁸	4.735 x 10 ⁻⁸	3.438 x 10 ⁻⁸	1.800 x 10 ⁻⁸	7.305 x 10 ⁻⁹	3.760 x 10 ⁻⁹	2.445 x 10 ⁻⁹	1.777 x 10 ⁻⁹
WNW	2.032 x 10 ⁻⁷	1.085 x 10 ⁻⁷	6.167 x 10 ⁻⁸	4.047 x 10 ⁻⁸	2.918 x 10 ⁻⁸	1.515 x 10 ⁻⁸	6.103 x 10 ⁻⁹	3.132 x 10 ⁻⁹	2.036 x 10 ⁻⁹	1.480 x 10 ⁻⁹
NW	1.796 x 10 ⁻⁷	1.080 x 10 ⁻⁷	6.754 x 10 ⁻⁸	4.674 x 10 ⁻⁸	3.492 x 10 ⁻⁸	1.911 x 10 ⁻⁸	8.213 x 10 ⁻⁹	4.375 x 10 ⁻⁹	2.897 x 10 ⁻⁹	2.131 x 10 ⁻⁹
NNW	1.648 x 10 ⁻⁷	9.680 x 10 ⁻⁸	5.825 x 10 ⁻⁸	3.922 x 10 ⁻⁸	2.870 x 10 ⁻⁸	1.513 x 10 ⁻⁸	6.167 x 10 ⁻⁹	3.163 x 10 ⁻⁹	2.049 x 10 ⁻⁹	1.485 x 10 ⁻⁹
ANNUAL AVERAGE X/Q, DECAYED AND UNDEPLETED (sec/m ³)										
N	1.653 x 10 ⁻⁷	9.782 x 10 ⁻⁸	5.987 x 10 ⁻⁸	4.064 x 10 ⁻⁸	2.987 x 10 ⁻⁸	1.580 x 10 ⁻⁸	6.384 x 10 ⁻⁹	3.194 x 10 ⁻⁹	2.012 x 10 ⁻⁹	1.416 x 10 ⁻⁹
NNE	1.711 x 10 ⁻⁷	9.781 x 10 ⁻⁸	5.751 x 10 ⁻⁸	3.818 x 10 ⁻⁸	2.765 x 10 ⁻⁸	1.431 x 10 ⁻⁸	5.644 x 10 ⁻⁹	2.797 x 10 ⁻⁹	1.758 x 10 ⁻⁹	1.237 x 10 ⁻⁹
NE	1.846 x 10 ⁻⁷	1.135 x 10 ⁻⁷	6.986 x 10 ⁻⁸	4.741 x 10 ⁻⁸	3.481 x 10 ⁻⁸	1.833 x 10 ⁻⁸	7.366 x 10 ⁻⁹	3.679 x 10 ⁻⁹	2.319 x 10 ⁻⁹	1.634 x 10 ⁻⁹
ENE	1.974 x 10 ⁻⁷	1.181 x 10 ⁻⁷	7.168 x 10 ⁻⁸	4.831 x 10 ⁻⁸	3.530 x 10 ⁻⁸	1.850 x 10 ⁻⁸	7.377 x 10 ⁻⁹	3.658 x 10 ⁻⁹	2.294 x 10 ⁻⁹	1.610 x 10 ⁻⁹
E	2.586 x 10 ⁻⁷	1.484 x 10 ⁻⁷	8.779 x 10 ⁻⁸	5.858 x 10 ⁻⁸	4.263 x 10 ⁻⁸	2.227 x 10 ⁻⁸	8.914 x 10 ⁻⁹	4.466 x 10 ⁻⁹	2.822 x 10 ⁻⁹	1.990 x 10 ⁻⁹
ESE	2.813 x 10 ⁻⁷	1.575 x 10 ⁻⁷	9.108 x 10 ⁻⁸	5.998 x 10 ⁻⁸	4.324 x 10 ⁻⁸	2.225 x 10 ⁻⁸	8.716 x 10 ⁻⁹	4.304 x 10 ⁻⁹	2.700 x 10 ⁻⁹	1.896 x 10 ⁻⁹
SE	2.359 x 10 ⁻⁷	1.351 x 10 ⁻⁷	7.808 x 10 ⁻⁸	5.113 x 10 ⁻⁸	3.666 x 10 ⁻⁸	1.868 x 10 ⁻⁸	7.199 x 10 ⁻⁹	3.511 x 10 ⁻⁹	2.187 x 10 ⁻⁹	1.529 x 10 ⁻⁹

Table G-3. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Elevated Releases (continued)

Direction from site	Distance (km)									
	0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
ANNUAL AVERAGE X/Q, DECAYED AND UNDEPLETED (sec/m ³) (continued)										
SSE	1.604×10^{-7}	8.673×10^{-8}	4.979×10^{-8}	3.276×10^{-8}	2.362×10^{-8}	1.218×10^{-8}	4.799×10^{-9}	2.384×10^{-9}	1.501×10^{-9}	1.057×10^{-9}
S	9.914×10^{-8}	5.259×10^{-8}	3.148×10^{-8}	2.147×10^{-8}	1.591×10^{-8}	8.596×10^{-9}	3.597×10^{-9}	1.853×10^{-9}	1.188×10^{-9}	8.459×10^{-10}
SSW	9.486×10^{-8}	5.345×10^{-8}	3.254×10^{-8}	2.221×10^{-8}	1.643×10^{-8}	8.841×10^{-9}	3.683×10^{-9}	1.894×10^{-9}	1.213×10^{-9}	8.643×10^{-10}
SW	1.624×10^{-7}	9.201×10^{-8}	5.553×10^{-8}	3.787×10^{-8}	2.807×10^{-8}	1.523×10^{-8}	6.462×10^{-9}	3.384×10^{-9}	2.195×10^{-9}	1.578×10^{-9}
WSW	2.033×10^{-7}	1.103×10^{-7}	6.261×10^{-8}	4.105×10^{-8}	2.955×10^{-8}	1.523×10^{-8}	6.004×10^{-9}	2.997×10^{-9}	1.895×10^{-9}	1.340×10^{-9}
W	2.207×10^{-7}	1.224×10^{-7}	7.087×10^{-8}	4.690×10^{-8}	3.397×10^{-8}	1.765×10^{-8}	7.021×10^{-9}	3.515×10^{-9}	2.225×10^{-9}	1.573×10^{-9}
WNW	2.027×10^{-7}	1.080×10^{-7}	6.124×10^{-8}	4.008×10^{-8}	2.882×10^{-8}	1.485×10^{-8}	5.856×10^{-9}	2.918×10^{-9}	1.843×10^{-9}	1.301×10^{-9}
NW	1.791×10^{-7}	1.075×10^{-7}	6.703×10^{-8}	4.625×10^{-8}	3.445×10^{-8}	1.869×10^{-8}	7.863×10^{-9}	4.064×10^{-9}	2.612×10^{-9}	1.865×10^{-9}
NNW	1.644×10^{-7}	9.637×10^{-8}	5.783×10^{-8}	3.883×10^{-8}	2.833×10^{-8}	1.482×10^{-8}	5.917×10^{-9}	2.949×10^{-9}	1.857×10^{-9}	1.308×10^{-9}
ANNUAL AVERAGE X/Q, DECAYED AND DEPLETED (sec/m ³)										
N	1.617×10^{-7}	9.484×10^{-8}	5.757×10^{-8}	3.886×10^{-8}	2.845×10^{-8}	1.493×10^{-8}	5.959×10^{-9}	2.962×10^{-9}	1.857×10^{-9}	1.294×10^{-9}
NNE	1.673×10^{-7}	9.451×10^{-8}	5.490×10^{-8}	3.613×10^{-8}	2.600×10^{-8}	1.328×10^{-8}	5.120×10^{-9}	2.494×10^{-9}	1.546×10^{-9}	1.069×10^{-9}
NE	1.807×10^{-7}	1.100×10^{-7}	6.711×10^{-8}	4.524×10^{-8}	3.305×10^{-8}	1.724×10^{-8}	6.824×10^{-9}	3.375×10^{-9}	2.112×10^{-9}	1.472×10^{-9}
ENE	1.931×10^{-7}	1.145×10^{-7}	6.882×10^{-8}	4.606×10^{-8}	3.349×10^{-8}	1.738×10^{-8}	6.820×10^{-9}	3.348×10^{-9}	2.084×10^{-9}	1.446×10^{-9}
E	2.528×10^{-7}	1.435×10^{-7}	8.396×10^{-8}	5.561×10^{-8}	4.024×10^{-8}	2.080×10^{-8}	8.195×10^{-9}	4.068×10^{-9}	2.554×10^{-9}	1.783×10^{-9}
ESE	2.750×10^{-7}	1.520×10^{-7}	8.673×10^{-8}	5.655×10^{-8}	4.046×10^{-8}	2.051×10^{-8}	7.833×10^{-9}	3.791×10^{-9}	2.342×10^{-9}	1.615×10^{-9}
SE	2.308×10^{-7}	1.304×10^{-7}	7.426×10^{-8}	4.809×10^{-8}	3.418×10^{-8}	1.711×10^{-8}	6.395×10^{-9}	3.040×10^{-9}	1.857×10^{-9}	1.270×10^{-9}
SSE	1.567×10^{-7}	8.367×10^{-8}	4.746×10^{-8}	3.095×10^{-8}	2.217×10^{-8}	1.129×10^{-8}	4.344×10^{-9}	2.119×10^{-9}	1.314×10^{-9}	9.085×10^{-10}
S	9.680×10^{-8}	5.077×10^{-8}	3.010×10^{-8}	2.041×10^{-8}	1.506×10^{-8}	8.068×10^{-9}	3.330×10^{-9}	1.702×10^{-9}	1.084×10^{-9}	7.636×10^{-10}
SSW	9.270×10^{-8}	5.176×10^{-8}	3.126×10^{-8}	2.122×10^{-8}	1.565×10^{-8}	8.362×10^{-9}	3.450×10^{-9}	1.767×10^{-9}	1.130×10^{-9}	7.988×10^{-10}
SW	1.587×10^{-7}	8.906×10^{-8}	5.332×10^{-8}	3.619×10^{-8}	2.674×10^{-8}	1.444×10^{-8}	6.092×10^{-9}	3.193×10^{-9}	2.075×10^{-9}	1.487×10^{-9}
WSW	1.985×10^{-7}	1.062×10^{-7}	5.949×10^{-8}	3.862×10^{-8}	2.760×10^{-8}	1.402×10^{-8}	5.392×10^{-9}	2.638×10^{-9}	1.642×10^{-9}	1.139×10^{-9}
W	2.156×10^{-7}	1.181×10^{-7}	6.755×10^{-8}	4.433×10^{-8}	3.190×10^{-8}	1.637×10^{-8}	6.379×10^{-9}	3.144×10^{-9}	1.965×10^{-9}	1.368×10^{-9}
WNW	1.980×10^{-7}	1.041×10^{-7}	5.819×10^{-8}	3.770×10^{-8}	2.690×10^{-8}	1.365×10^{-8}	5.239×10^{-9}	2.555×10^{-9}	1.585×10^{-9}	1.096×10^{-9}
NW	1.752×10^{-7}	1.042×10^{-7}	6.453×10^{-8}	4.431×10^{-8}	3.290×10^{-8}	1.775×10^{-8}	7.415×10^{-9}	3.830×10^{-9}	2.463×10^{-9}	1.751×10^{-9}
NNW	1.608×10^{-7}	9.323×10^{-8}	5.532×10^{-8}	3.684×10^{-8}	2.673×10^{-8}	1.382×10^{-8}	5.410×10^{-9}	2.659×10^{-9}	1.658×10^{-9}	1.151×10^{-9}

Table G-3. Annual Average Meteorological Dispersion/Deposition Parameters Within 80 Kilometers of SRP Center for Elevated Releases (continued)

Direction from site	Distance (km)									
	0-2	2-3	3-5	5-6	6-8	8-16	16-32	32-48	48-64	64-80
ANNUAL AVERAGE D/Q (m^{-2})										
N	2.473×10^{-9}	9.109×10^{-10}	4.045×10^{-10}	2.331×10^{-10}	1.539×10^{-10}	6.845×10^{-11}	2.264×10^{-11}	1.049×10^{-11}	6.614×10^{-12}	4.729×10^{-12}
NNE	2.697×10^{-9}	1.011×10^{-9}	4.511×10^{-10}	2.602×10^{-10}	1.717×10^{-10}	7.626×10^{-11}	2.506×10^{-11}	1.151×10^{-11}	7.194×10^{-12}	5.100×10^{-12}
NE	2.740×10^{-9}	1.038×10^{-9}	4.647×10^{-10}	2.682×10^{-10}	1.770×10^{-10}	7.851×10^{-11}	2.569×10^{-11}	1.179×10^{-11}	7.421×10^{-12}	5.323×10^{-12}
ENE	2.811×10^{-9}	1.059×10^{-9}	4.737×10^{-10}	2.733×10^{-10}	1.804×10^{-10}	8.005×10^{-11}	2.625×10^{-11}	1.205×10^{-11}	7.565×10^{-12}	5.399×10^{-12}
E	3.650×10^{-9}	1.369×10^{-9}	6.114×10^{-10}	3.527×10^{-10}	2.327×10^{-10}	1.033×10^{-10}	3.394×10^{-11}	1.559×10^{-11}	9.764×10^{-12}	6.939×10^{-12}
ESE	4.124×10^{-9}	1.582×10^{-9}	7.110×10^{-10}	4.104×10^{-10}	2.708×10^{-10}	1.200×10^{-10}	3.908×10^{-11}	1.776×10^{-11}	1.100×10^{-11}	7.739×10^{-12}
SE	4.028×10^{-9}	1.575×10^{-9}	7.119×10^{-10}	4.113×10^{-10}	2.714×10^{-10}	1.200×10^{-10}	3.880×10^{-11}	1.747×10^{-11}	1.072×10^{-11}	7.461×10^{-12}
SSE	2.366×10^{-9}	8.707×10^{-10}	3.865×10^{-10}	2.228×10^{-10}	1.470×10^{-10}	6.541×10^{-11}	2.164×10^{-11}	9.996×10^{-12}	6.248×10^{-12}	4.412×10^{-12}
S	1.385×10^{-9}	4.897×10^{-10}	2.146×10^{-10}	1.235×10^{-10}	8.152×10^{-11}	3.642×10^{-11}	1.224×10^{-11}	5.765×10^{-12}	3.666×10^{-12}	2.621×10^{-12}
SSW	1.251×10^{-9}	4.481×10^{-10}	1.972×10^{-10}	1.136×10^{-10}	7.496×10^{-11}	3.344×10^{-11}	1.118×10^{-11}	5.246×10^{-12}	3.340×10^{-12}	2.407×10^{-12}
SW	1.979×10^{-9}	7.211×10^{-10}	3.191×10^{-10}	1.839×10^{-10}	1.213×10^{-10}	5.404×10^{-11}	1.796×10^{-11}	8.384×10^{-12}	5.355×10^{-12}	3.888×10^{-12}
WSW	3.024×10^{-9}	1.120×10^{-9}	4.979×10^{-10}	2.870×10^{-10}	1.894×10^{-10}	8.423×10^{-11}	2.780×10^{-11}	1.282×10^{-11}	8.021×10^{-12}	5.678×10^{-12}
W	3.342×10^{-9}	1.228×10^{-9}	5.447×10^{-10}	3.139×10^{-10}	2.072×10^{-10}	9.220×10^{-11}	3.052×10^{-11}	1.412×10^{-11}	8.852×10^{-12}	6.275×10^{-12}
WNW	3.053×10^{-9}	1.120×10^{-9}	4.969×10^{-10}	2.864×10^{-10}	1.890×10^{-10}	8.411×10^{-11}	2.785×10^{-11}	1.288×10^{-11}	8.043×10^{-12}	5.673×10^{-12}
NW	2.555×10^{-9}	9.364×10^{-10}	4.152×10^{-10}	2.393×10^{-10}	1.579×10^{-10}	7.028×10^{-11}	2.330×10^{-11}	1.085×10^{-11}	6.912×10^{-12}	5.008×10^{-12}
NNW	2.415×10^{-9}	9.062×10^{-10}	4.047×10^{-10}	2.334×10^{-10}	1.540×10^{-10}	6.840×10^{-11}	2.246×10^{-11}	1.032×10^{-11}	6.468×10^{-12}	4.602×10^{-12}

Table G-4. Population and Annual Food Production Within 80 Kilometers of the SRP Center^a

Direction	Distance (km)						
	0-8	8-16	16-32	32-48	48-64	64-80	0-80
POPULATION							
N	0	1,507	5,589	7,411	8,541	20,725	43,774
NNE	0	70	1,118	2,952	4,899	17,585	26,623
NE	0	283	1,218	5,213	9,295	12,435	28,443
ENE	0	25	6,783	5,150	8,039	44,590	64,586
E	0	0	3,203	11,430	6,029	9,672	30,334
ESE	0	0	5,778	4,899	4,208	4,333	19,218
SE	0	0	452	7,285	5,652	9,797	23,187
SSE	0	0	766	1,143	565	5,087	7,561
S	0	0	1,080	1,570	7,034	3,957	13,641
SSW	0	0	264	2,387	6,908	3,454	13,013
SW	0	0	553	3,894	2,261	3,140	9,847
WSW	0	0	496	5,652	1,821	7,662	15,632
W	0	440	2,575	9,420	3,705	12,435	28,575
WNW	0	4,019	5,778	247,443	84,156	15,701	357,096
NW	0	1,118	15,701	64,059	5,778	2,512	89,167
NNW	0	4,208	40,822	16,957	14,445	4,899	81,330
Total ^b	0	11,670	92,176	396,863	173,336	177,983	852,027
MILK PRODUCTION (liters/yr)							
N	0	1.64×10^4	1.03×10^5	1.72×10^5	1.41×10^6	5.57×10^6	7.28×10^6
NNE	0	1.31×10^4	1.03×10^5	1.72×10^5	3.68×10^5	6.06×10^5	1.26×10^6
NE	0	5.73×10^3	1.22×10^5	1.33×10^6	2.15×10^6	1.39×10^6	4.99×10^6
ENE	0	1.58×10^3	1.80×10^5	1.92×10^6	4.82×10^6	5.46×10^6	1.24×10^7
E	0	1.85×10^3	1.80×10^5	1.74×10^6	4.15×10^6	5.76×10^6	1.18×10^7
ESE	0	4.51×10^1	1.80×10^5	9.31×10^5	2.84×10^6	1.46×10^6	5.41×10^6
SE	0	--	1.21×10^5	4.52×10^4	1.80×10^5	4.00×10^5	7.46×10^5
SSE	0	--	9.38×10^4	2.41×10^5	3.52×10^5	5.64×10^5	1.25×10^6
S	0	--	3.31×10^5	5.74×10^5	7.70×10^5	9.97×10^5	2.67×10^6
SSW	0	--	3.58×10^5	1.89×10^6	6.40×10^6	7.61×10^6	1.63×10^7
SW	0	7.65×10^3	3.87×10^5	6.71×10^5	3.07×10^6	2.84×10^6	6.97×10^6
WSW	0	2.47×10^3	3.53×10^5	6.68×10^5	1.05×10^6	2.40×10^6	4.47×10^6
W	0	1.16×10^4	1.81×10^5	3.79×10^5	1.01×10^6	1.77×10^6	3.36×10^6
WNW	0	1.38×10^4	1.79×10^5	3.46×10^5	6.13×10^5	8.55×10^5	2.01×10^6
NW	0	1.75×10^4	1.03×10^5	4.24×10^5	1.16×10^6	7.81×10^5	2.49×10^6
NNW	0	1.79×10^4	1.03×10^5	2.95×10^5	1.48×10^6	3.14×10^6	5.04×10^6
Total ^b	0	1.10×10^5	3.08×10^6	1.18×10^7	3.18×10^7	4.16×10^7	8.84×10^7

Table G-4. Population and Annual Food Production Within 80 Kilometers of the SRP Center^a (continued)

Direction	Distance (km)						
	0-8	8-16	16-32	32-48	48-64	64-80	0-80
MEAT PRODUCTION (kg/yr)							
N	0	8.32×10^4	5.24×10^5	8.73×10^5	1.41×10^6	3.15×10^6	6.05×10^6
NNE	0	6.63×10^4	5.24×10^5	8.73×10^5	2.29×10^6	4.06×10^6	7.81×10^6
NE	0	2.37×10^4	4.71×10^5	7.80×10^5	1.71×10^6	3.01×10^6	5.99×10^6
ENE	0	2.65×10^3	3.02×10^5	5.50×10^5	8.87×10^5	1.06×10^6	2.80×10^6
E	0	3.10×10^3	3.02×10^5	4.74×10^5	6.89×10^5	1.03×10^6	2.50×10^6
ESE	0	7.56×10^1	3.02×10^5	4.66×10^5	6.14×10^5	7.10×10^5	2.09×10^6
SE	0	--	2.74×10^5	3.82×10^5	6.56×10^5	1.00×10^6	2.31×10^6
SSE	0	--	2.35×10^5	4.35×10^5	6.19×10^5	9.88×10^5	2.28×10^6
S	0	--	1.75×10^5	4.58×10^5	7.32×10^5	1.02×10^6	2.39×10^6
SSW	0	--	1.57×10^5	3.93×10^5	1.13×10^6	1.58×10^6	3.26×10^6
SW	0	2.29×10^3	1.33×10^5	2.01×10^5	5.76×10^5	7.57×10^5	1.67×10^6
WSW	0	1.06×10^4	1.75×10^5	2.00×10^5	3.09×10^5	6.65×10^5	1.36×10^6
W	0	5.90×10^4	1.66×10^5	1.19×10^5	2.91×10^5	5.11×10^5	1.15×10^6
WNW	0	7.01×10^4	1.75×10^5	1.09×10^5	1.76×10^5	2.45×10^5	7.75×10^5
NW	0	8.86×10^4	5.24×10^5	6.98×10^5	5.83×10^5	7.01×10^5	2.60×10^6
NNW	0	9.11×10^4	5.24×10^5	8.20×10^5	7.14×10^5	1.45×10^6	3.60×10^6
Total ^b	0	5.01×10^5	4.96×10^6	7.83×10^6	1.34×10^7	2.20×10^7	4.86×10^7
VEGETABLE PRODUCTION (kg/yr)							
N	0	7.39×10^4	4.65×10^5	7.75×10^5	2.16×10^6	3.11×10^6	6.58×10^6
NNE	0	5.89×10^4	4.65×10^5	7.75×10^5	1.18×10^6	1.61×10^6	4.09×10^6
NE	0	4.13×10^4	9.71×10^5	1.08×10^6	1.59×10^6	1.93×10^6	5.61×10^6
ENE	0	2.25×10^4	2.57×10^6	2.89×10^6	2.21×10^6	2.78×10^6	1.05×10^7
E	0	2.64×10^4	2.57×10^6	3.01×10^6	2.72×10^6	3.03×10^6	1.14×10^7
ESE	0	6.44×10^2	2.57×10^6	3.82×10^6	3.44×10^6	9.66×10^5	1.08×10^7
SE	0	--	2.73×10^6	4.97×10^6	4.70×10^6	2.89×10^6	1.53×10^7
SSE	0	--	2.65×10^6	3.71×10^6	5.01×10^6	3.16×10^6	1.45×10^7
S	0	--	1.36×10^6	1.69×10^6	2.50×10^6	3.27×10^6	8.82×10^6
SSW	0	--	1.15×10^6	1.33×10^6	1.86×10^6	2.55×10^6	6.89×10^6
SW	0	1.51×10^4	9.20×10^5	1.33×10^6	1.81×10^6	1.97×10^6	6.04×10^6
WSW	0	1.01×10^4	7.21×10^5	1.31×10^6	1.86×10^6	2.41×10^6	6.31×10^6
W	0	5.23×10^4	1.86×10^5	3.17×10^5	1.18×10^6	2.77×10^6	4.51×10^6
WNW	0	6.22×10^4	1.94×10^5	1.70×10^5	4.89×10^4	1.36×10^6	1.83×10^6
NW	0	7.86×10^4	4.65×10^5	1.59×10^6	4.20×10^6	2.27×10^6	8.59×10^6
NNW	0	8.08×10^4	4.65×10^5	1.25×10^6	5.70×10^6	6.38×10^6	1.39×10^7
Total ^b	0	5.23×10^5	2.05×10^7	3.00×10^7	4.22×10^7	4.24×10^7	1.36×10^8

a. Adapted from Du Pont, 1981, 1982.

b. Reflects rounding.

| BC-22

| BC-22

given in Chapter 4 for each of the cooling alternatives. For facilities on or within 80 kilometers of SRP, the source terms were taken from supporting documentation referenced in Section G.3.

To calculate collective doses to the regional population within 80 kilometers, compass-sector average values of X/Q and D/Q are used. All atmospheric releases are assumed to occur at the center of the site; the population and agricultural production distributions were centered at the same points. These are reasonable assumptions, given the absence of high population densities near the release points. Collective doses for each year of operation were calculated as the sum of the doses received during that year of operation, plus residual doses for the next 100 years from radioactivity released during that same year. The calculated collective dose is referred to as a 100-year environmental dose commitment (EDC) per year of operation. (The EDC concept is discussed later in this appendix.) The collective dose received by the exposed offsite population is calculated by adding the individual dose commitments in the population. Parameters used in calculating the collective dose to the 80-kilometer radius population are summarized in Table G-5.

The maximally exposed individual is assumed to reside continuously at the location on the Plant boundary with the highest potential exposure. This is true for both current operating conditions and operations associated with the implementation of cooling alternatives. For the latter, the reference release points of radioactivity to the atmosphere are at the midpoint between the two cooling alternative locations selected for each reactor (K and C). The shortest distance from each of the reference release points to the Plant boundary was calculated for each of the 16 cardinal directions. This method was used to determine the highest boundary X/Q value, thus identifying the location at which a member of the public would receive the highest dose.

All individual doses are 50-year dose commitments. Parameters used in calculating doses to maximally exposed individuals are summarized in Table G-6.

The following exposure pathways were considered for the atmospheric dose assessment:

1. Plume - External dose from radioactive materials transported through the atmosphere
2. Ground - External dose from radioactive materials deposited on the ground
3. Inhalation - Internal dose from inhalation of radioactive materials transported through the atmosphere
4. Vegetation - Internal dose from consumption of crops that have been contaminated by radioactive deposits from the atmosphere
5. Milk - Internal dose from consumption of milk from cows that consume vegetation contaminated by radioactive deposits from the atmosphere
6. Meat - Internal dose from consumption of meat products from beef cattle that consume vegetation contaminated by radioactive deposits from the atmosphere

Table G-5. Parameters and Demographic Data Used in Calculating Collective Dose to the 80-Kilometer Population

Average individual parameters ^a	Child	Teen	Adult
Inhalation (m^3/yr)	3700	8000	8000
Ingestion ^b			
Cow's milk (liter/yr)	170	200	110
Meat (kg/yr)	37	59	95
Leafy vegetables (kg/yr) ^c	10	20	30
Fruits, vegetables, and grains (kg/yr)	200	240	190
External exposure			
Transmission factor for shielding by residential structures	0.5	0.5	0.5
Demographic data, CY 2000 ^d			
80-kilometer residential population (852,000) age-group distribution	20.8	11.8	67.4

- a. Data are recommended values from Regulatory Guide 1.109 (NRC, 1977).
- b. Foodstuff obtained at large from the 80-kilometer agricultural production of man's foods; any insufficiency is assumed to be imported (uncontaminated). Crop yield and animal feeding data for the 80-kilometer vicinity are presented in Du Pont (1981).
- c. Data from Eckerman et al. (1980).
- d. 1970 census data projected to the assumed midpoint of operations.

The dose to the maximally exposed individual and collective doses to the population within 80 kilometers of SRP from atmospheric radioactive releases from once-through and recirculating cooling towers for K- and C-Reactors are presented in Tables G-7 through G-14. Section G.3 discusses doses from facilities on or within 80 kilometers of the Plant.

G.2 LIQUID RELEASES

The LADTAP II computer code (Simpson and McGill, 1980) was used to calculate radiation exposures due to liquid releases; LADTAP II implements the dose models recommended in NRC Regulatory Guide 1.109, Revision 1 (NRC, 1977). Both maximum-individual and collective doses were calculated as functions of age group and pathway for various body organs. An effective whole-body dose was also calculated.

During operation of the reactors and associated facilities at SRP (existing operations), liquids are released that ultimately discharge into the Savannah River. Included in these releases are radionuclides from reactors and support facilities, and from remobilization from stream beds. The primary radionuclides remobilized is cesium-137 (DOE, 1984b). (Refer to Appendix D.)

Table G-6. Parameters Used in Calculating Dose to Maximally Exposed Individuals^a

Parameter	Infant	Child	Teen	Adult
Inhalation (m^3/yr)	1400	3700	8000	8000
Ingestion ^b				
Cow's milk (liter/yr)	330	330	400	310
Meat (kg/yr)	0	41	65	110
Leafy vegetables (kg/yr) ^c	0	26	42	64
Fruits, vegetables, and grains (kg/yr) ^d	0	520	630	520
External exposure				
Transmission factor for shielding from buildings	0.7	0.7	0.7	0.7

- a. Data are recommended values from Regulatory Guide 1.109 (NRC, 1977).
- b. Foodstuff produced at the reference family's location, except as noted, where exposure to the air-released radionuclides is at a maximum. Crop yield and animal feeding parameters are presented in Du Pont (1981).
- c. Seventy-five percent taken from reference family's garden (March-November growing season); remainder imported (uncontaminated).
- d. Seventy-six percent taken from reference family's crops (Regulatory Guide 1.109 recommended value) (NRC, 1977); remainder imported (uncontaminated).

The routine operation of cooling water systems for K- and C-Reactors would result in either no change or a decrease in the remobilization of radionuclides to the Savannah River. This is because flow rates in Four Mile Creek and Indian Grave/Pen Branch would remain essentially unchanged if once-through cooling towers were implemented, and would decrease if recirculating cooling towers were implemented. The routine operation of the cooling water alternative systems for D-Area would produce an insignificant increase in remobilization of radionuclides from Beaver Dam Creek because the creek bed contains insignificant amounts of radionuclides.

The following exposure pathways were considered in the liquid-dose assessments:

1. Drinking water - Internal dose from consumption of drinking water from the Savannah River containing radioactive materials transported by the river
2. Sport and commercial fish - Internal dose from consumption of fish from the Savannah River

Table G-7. Increase in Annual Dose to Maximally Exposed Individual from Increased Release of Tritium to the Atmosphere, Millirem per Year (Once-Through Cooling Tower for K-Reactor)

Pathway	All soft tissues	Effective whole body
ADULT		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	5.28×10^{-5}	4.49×10^{-5}
Meat ingestion	7.86×10^{-6}	6.68×10^{-6}
Milk ingestion	1.85×10^{-5}	1.57×10^{-5}
Inhalation	4.43×10^{-5}	3.77×10^{-5}
Total	1.23×10^{-4}	1.05×10^{-4}
TEEN		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	6.08×10^{-5}	5.17×10^{-5}
Meat ingestion	4.65×10^{-6}	3.95×10^{-6}
Milk ingestion	2.38×10^{-5}	2.02×10^{-5}
Inhalation	4.43×10^{-5}	3.77×10^{-5}
Total	1.34×10^{-4}	1.14×10^{-4}
CHILD		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	4.94×10^{-5}	4.20×10^{-5}
Meat ingestion	2.93×10^{-6}	2.49×10^{-6}
Milk ingestion	1.97×10^{-5}	1.67×10^{-5}
Inhalation	2.04×10^{-5}	1.74×10^{-5}
Total	9.24×10^{-5}	7.86×10^{-5}
INFANT		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	0.0	0.0
Meat ingestion	0.0	0.0
Milk ingestion	1.97×10^{-5}	1.67×10^{-5}
Inhalation	7.74×10^{-6}	6.59×10^{-6}
Total	2.74×10^{-5}	2.33×10^{-5}

Table G-8. Increase in Annual Dose to Maximally Exposed Individual from Increased Release of Tritium to the Atmosphere, Millirem per Year (Once-Through Cooling Tower for C-Reactor)

Pathway	All soft tissues	Effective whole body
ADULT		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	5.44×10^{-5}	4.62×10^{-5}
Meat ingestion	8.10×10^{-6}	6.89×10^{-6}
Milk ingestion	1.90×10^{-5}	1.62×10^{-5}
Inhalation	4.56×10^{-5}	3.87×10^{-5}
Total	1.27×10^{-4}	1.08×10^{-4}
TEEN		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	6.26×10^{-5}	5.32×10^{-5}
Meat ingestion	4.78×10^{-6}	4.06×10^{-6}
Milk ingestion	2.45×10^{-5}	2.08×10^{-5}
Inhalation	4.56×10^{-5}	3.87×10^{-5}
Total	1.37×10^{-4}	1.17×10^{-4}
CHILD		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	5.09×10^{-5}	4.33×10^{-5}
Meat ingestion	3.02×10^{-6}	2.57×10^{-6}
Milk ingestion	2.02×10^{-5}	1.72×10^{-5}
Inhalation	2.10×10^{-5}	1.79×10^{-5}
Total	9.51×10^{-5}	8.09×10^{-5}
INFANT		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	0.0	0.0
Meat ingestion	0.0	0.0
Milk ingestion	2.02×10^{-5}	1.72×10^{-5}
Inhalation	7.97×10^{-6}	6.77×10^{-6}
Total	2.82×10^{-5}	2.40×10^{-5}

Table G-9. Increase in Annual Dose to Maximally Exposed Individual from Increased Release of Tritium to the Atmosphere, Millirem per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	All soft tissues	Effective whole body
ADULT		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	4.48×10^{-4}	3.80×10^{-4}
Meat ingestion	6.68×10^{-5}	5.67×10^{-5}
Milk ingestion	1.57×10^{-4}	1.33×10^{-4}
Inhalation	3.77×10^{-4}	3.21×10^{-4}
Total	1.05×10^{-3}	8.92×10^{-4}
TEEN		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	5.15×10^{-4}	4.39×10^{-4}
Meat ingestion	3.93×10^{-5}	3.35×10^{-5}
Milk ingestion	2.02×10^{-4}	1.72×10^{-4}
Inhalation	3.77×10^{-4}	3.21×10^{-4}
Total	1.13×10^{-3}	9.65×10^{-4}
CHILD		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	4.20×10^{-4}	3.58×10^{-4}
Meat ingestion	2.48×10^{-5}	2.11×10^{-5}
Milk ingestion	1.67×10^{-4}	1.42×10^{-4}
Inhalation	1.74×10^{-4}	1.48×10^{-4}
Total	7.87×10^{-4}	6.69×10^{-4}
INFANT		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	0.0	0.0
Meat ingestion	0.0	0.0
Milk ingestion	1.67×10^{-4}	1.42×10^{-4}
Inhalation	6.56×10^{-5}	5.57×10^{-5}
Total	2.32×10^{-4}	1.98×10^{-4}

Table G-10. Increase in Annual Dose to Maximally Exposed Individual from Increased Release of Tritium to the Atmosphere, Millirem per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	All soft tissues	Effective whole body
ADULT		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	4.62×10^{-4}	3.93×10^{-4}
Meat ingestion	6.88×10^{-5}	5.84×10^{-5}
Milk ingestion	1.62×10^{-4}	1.37×10^{-4}
Inhalation	3.86×10^{-4}	3.27×10^{-4}
Total	1.08×10^{-3}	9.15×10^{-4}
TEEN		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	5.33×10^{-4}	4.51×10^{-4}
Meat ingestion	4.06×10^{-5}	3.46×10^{-5}
Milk ingestion	2.09×10^{-4}	1.78×10^{-4}
Inhalation	3.86×10^{-4}	3.27×10^{-4}
Total	1.17×10^{-3}	9.91×10^{-4}
CHILD		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	4.33×10^{-4}	3.68×10^{-4}
Meat ingestion	2.57×10^{-5}	2.17×10^{-5}
Milk ingestion	1.72×10^{-4}	1.46×10^{-4}
Inhalation	1.79×10^{-4}	1.52×10^{-4}
Total	8.09×10^{-4}	6.87×10^{-4}
INFANT		
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	0.0	0.0
Meat ingestion	0.0	0.0
Milk ingestion	1.72×10^{-4}	1.46×10^{-4}
Inhalation	6.77×10^{-5}	5.75×10^{-5}
Total	2.40×10^{-4}	2.03×10^{-4}

Table G-11. Increase in 80-Kilometer Collective Dose from Increased Release of Tritium to the Atmosphere, Person-Rem per Year (Once-Through Cooling Tower for K-Reactor)

Pathway	All soft tissues	Effective whole body
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	1.59×10^{-3}	1.35×10^{-3}
Meat ingestion	3.03×10^{-4}	2.58×10^{-4}
Milk ingestion	3.85×10^{-4}	3.27×10^{-4}
Inhalation	3.57×10^{-3}	3.03×10^{-3}
Total	5.85×10^{-3}	4.97×10^{-3}

Table G-12. Increase in 80-Kilometer Collective Dose from Increased Release of Tritium to the Atmosphere, Person-Rem per Year (Once-Through Cooling Tower for C-Reactor)

Pathway	All soft tissues	Effective whole body
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	1.59×10^{-3}	1.35×10^{-3}
Meat ingestion	3.03×10^{-4}	2.58×10^{-4}
Milk ingestion	3.85×10^{-4}	3.27×10^{-4}
Inhalation	3.57×10^{-3}	3.03×10^{-3}
Total	5.85×10^{-3}	4.97×10^{-3}

3. Salt-water invertebrates - Internal dose from consumption of shellfish from estuaries of the Savannah River

4. Recreation - External dose from recreational activities on or along the Savannah River shoreline

All individual and collective doses were based on the assumption that liquids discharged are mixed completely in the river before reaching the potential exposure pathways. This assumption is supported by measurements that indicate complete mixing of the liquids before they reach the Highway 301 bridge. A dilution factor of 3 was applied to the shellfish dose calculation because a significant portion of the harvest would be from estuarine or ocean waters.

Individual and site parameters used in the calculations are summarized in Tables G-15 and G-16. The data on fish consumption are based on data from the region.

Table G-13. Increase in 80-Kilometer Collective Dose from Increased Release of Tritium to the Atmosphere, Person-Rem per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	All soft tissues	Effective whole body
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	1.35×10^{-2}	1.15×10^{-2}
Meat ingestion	2.57×10^{-3}	2.18×10^{-3}
Milk ingestion	3.28×10^{-3}	2.78×10^{-3}
Inhalation	3.03×10^{-2}	2.59×10^{-2}
Total	4.98×10^{-2}	4.22×10^{-2}

Table G-14. Increase in 80-Kilometer Collective Dose from Increased Release of Tritium to the Atmosphere, Person-Rem per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	All soft tissues	Effective whole body
Plume immersion	0.0	0.0
Ground plane	0.0	0.0
Vegetation ingestion	1.35×10^{-2}	1.15×10^{-2}
Meat ingestion	2.57×10^{-3}	2.18×10^{-3}
Milk ingestion	3.28×10^{-3}	2.78×10^{-3}
Inhalation	3.03×10^{-2}	2.59×10^{-2}
Total	4.98×10^{-2}	4.22×10^{-2}

TE | The individual who would receive the maximum potential dose from liquid releases is assumed to live near the Savannah River downstream from SRP. It is assumed this individual uses river water regularly for drinking, consumes river fish, and receives external exposure from shoreline activities.

TE | The collective doses received by the offsite population as a result of liquid releases is estimated by summing the doses to the individuals in the population. The population within an 80-kilometer radius uses no river water for domestic purposes downstream from SRP. It is assumed this population uses the river for recreational purposes and consumes fish and shellfish from the river and its estuary.

There is no known human consumption of Savannah River water up to a distance of about 160 kilometers downstream from SRP. At this distance, Beaufort and Jasper Counties, South Carolina, will pump water from the river for treatment

Table G-15. Individual Parameters Used in Dose Calculations

Parameters	Child	Teen	Adult
AVERAGE INDIVIDUAL ^a			
Water consumption (liter/year)	260	260	370
Fish consumption (kg/yr)	3.6	8.5	11.3
Other seafood consumption (kg/yr)	0.33	0.75	1.0
Shoreline recreation (hr/yr)	9.5	47	8.3
Shoreline recreation (person-hours)	--	--	200,000
MAXIMUM INDIVIDUAL			
Water consumption (liter/yr) ^b	510	510	730
Fish consumption (kg/yr)	11.2	25.9	34
Other seafood consumption (kg/yr)	1.7	3.8	5
Shoreline recreation (hr/yr)	14	67	20

a. For collective dose calculations.

b. Drinking-water consumption for an infant equals 330 liters per year.

Table G-16. Site Parameters Used in Dose Calculations

Parameters	Values
River flow rate (m^3/s)	
Average (m^3/s)	294
Low flow (m^3/s)	173
River dilution in estuary	3
Transit time to river (hr)	24
Transit time, SRP to water-treatment plants (hr)	72
Water-treatment time (hr)	24
Aquatic food harvest (kg/yr)	
Fish--sport	90,700
Fish--commercial	31,800
Invertebrates--salt water	299,000
Irrigation	None
Shore-width factor	0.2
Population in year 2000 ^a	
Beaufort-Jasper water consumers	117,000
Port Wentworth water consumers	200,000
80-kilometer-radius population	852,000

a. Age distribution of population: Beaufort-Jasper--21 percent child, 10 percent teen, 69 percent adult; Port Wentworth--100 percent adult; 80-kilometer radius--21 percent child, 11 percent teen, 68 percent adult.

and service to about 117,000 people in the year 2000. Several kilometers farther downstream, the Cherokee Hill water-treatment plant draws water from the river to supply a business-industrial complex near Savannah, Georgia. This water is not used for normal domestic service, but it is assumed that about 200,000 people will use this water during the year 2000 (DOE, 1984a). Although these population groups are beyond the 80-kilometer radius, collective doses from drinking-water for these groups have been included in this document. All population doses are 100-year environmental dose commitments.

The doses to the maximally exposed individual and collective dose from liquid radioactive releases from once-through and recirculating cooling-towers for K- and C-Reactors are presented in Tables G-17 through G-28. Section G.3 discusses doses from facilities on or within 80 kilometers of SRP.

G.3 CUMULATIVE EFFECTS

The evaluation of the radiological impacts associated with the implementation of the alternative cooling water systems has also considered the cumulative effects of the operation of all other nuclear facilities in the affected region. This region includes SRP and the area within 80 kilometers of the Plant. These cumulative effects are summarized in Section 4.4.

Impacts for the following nuclear facilities, which represent existing and planned operations, have been considered in the calculation of cumulative effects:

- Four onsite production reactors (L, P, K, and C) using current cooling water systems, and associated support facilities
- The Defense Waste Processing Facility (DWPF) under construction at S-Area on the Plant
- The Fuel Materials Facility (FMF) under construction at F-Area on the Plant
- The Fuel Production Facility (FPF) to be constructed at H-Area on the Plant
- The Vogtle Electric Generating Station (VEGS) under construction across the Savannah River from the southwestern boundary of the site

The maximum individual and collective doses associated with each of these facilities are presented in Tables G-29, G-30, G-31, and G-32. These represent basecase doses. Information necessary for these dose calculations was derived from supporting environmental documentation available for each facility (DOE, 1982a,b; 1984a; Du Pont, 1983; Georgia Power Company, 1985).

To obtain the cumulative impact of the operation of nuclear facilities in the region, including the alternative cooling water systems, the changes in doses associated with operation of the cooling water systems (Tables G-7 through

Table G-17. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Release of Tritium to Indian Grave/Pen Branch, Millirem per Year (Once-Through Cooling Tower for K-Reactor)

Pathway	All soft tissues	Effective whole body
ADULT		
Fish Drinking	1.04×10^{-5}	8.84×10^{-6}
Total	2.47×10^{-4}	2.10×10^{-4}
	2.58×10^{-4}	2.19×10^{-4}
TEEN		
Fish Drinking	7.90×10^{-6}	6.72×10^{-6}
Total	1.73×10^{-4}	1.47×10^{-4}
	1.81×10^{-4}	1.54×10^{-4}
CHILD		
Fish Drinking	3.42×10^{-6}	2.91×10^{-6}
Total	1.73×10^{-4}	1.47×10^{-4}
	1.76×10^{-4}	1.50×10^{-4}
INFANT		
Drinking	1.12×10^{-4}	9.52×10^{-5}
Total	1.12×10^{-4}	9.52×10^{-5}

G-14 and G-17 through G-28) must be combined with the existing doses. These cumulative doses are presented in Tables G-33 through G-38.

G.4 ENVIRONMENTAL DOSE COMMITMENT CONCEPT

Man can receive doses externally from radioactive materials outside the body or internally from the intake of radioactive material by inhalation or ingestion. Radionuclides that enter the body are distributed to various organs and are removed by normal biological processes and radioactive decay. The rate at which each radionuclide is removed from the body depends on its chemical, physical, and radiological properties. Historically, dose calculations have included an accounting of doses resulting from the fraction of radionuclides retained in the body for 50 years following the year of intake. This 50-year integrating period is included in the dose-commitment factors used in these dose calculations.

Table G-18. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Release of Tritium to Four Mile Creek, Millirem per Year (Once-Through Cooling Tower for C-Reactor)

Pathway	All soft tissues	Effective whole body
ADULT		
Fish Drinking	1.04×10^{-5}	8.84×10^{-6}
	2.47×10^{-4}	2.10×10^{-4}
Total	2.58×10^{-4}	2.19×10^{-4}
TEEN		
Fish Drinking	7.90×10^{-6}	6.72×10^{-6}
	1.73×10^{-4}	1.47×10^{-4}
Total	1.81×10^{-4}	1.54×10^{-4}
CHILD		
Fish Drinking	3.42×10^{-6}	2.91×10^{-6}
	1.73×10^{-4}	1.47×10^{-4}
Total	1.76×10^{-4}	1.50×10^{-4}
INFANT		
Drinking	1.12×10^{-4}	9.52×10^{-5}
Total	1.12×10^{-4}	9.52×10^{-5}

Similarly, radioactive material released in any year remains in the environment for varying lengths of time, depending on many environmental factors and on the decay rate of each radionuclide. The environmental-dose-commitment (EDC) concept is employed to account for this residual activity.

The EDC concept has been developed by the U.S. Environmental Protection Agency (EPA, 1974). EPA has defined the environmental dose commitment as "the sum of all doses to individuals over the entire time period the material persists in the environment in a state available for interaction with humans." The EPA report describes how this concept is implemented and presents some sample calculations. These calculations integrate doses for 100 years following radionuclide release rather than "the entire time period." This 100-year integrating period is distinct from the 50-year integrating period discussed above because it deals with the accumulation of doses from residual radioactivity in the environment rather than in the body.

Table G-19. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Release of Tritium to Indian Grave/Pen Branch, Millirem per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	All soft tissues	Effective whole body
ADULT		
Fish	8.81×10^{-5}	7.48×10^{-5}
Drinking	2.09×10^{-3}	1.78×10^{-3}
Total	2.18×10^{-3}	1.85×10^{-3}
TEEN		
Fish	6.72×10^{-5}	5.70×10^{-5}
Drinking	1.47×10^{-3}	1.25×10^{-3}
Total	1.53×10^{-3}	1.31×10^{-3}
CHILD		
Fish	2.90×10^{-5}	2.47×10^{-5}
Drinking	1.47×10^{-3}	1.25×10^{-3}
Total	1.50×10^{-3}	1.27×10^{-3}
INFANT		
Drinking	9.48×10^{-4}	8.06×10^{-4}
Total	9.48×10^{-4}	8.06×10^{-4}

This analysis uses the 100-year integrating period. All collective dose calculations include an accounting of collective dose resulting from environmental radioactivity levels for 100 years following each year's release. The 100-year period provides meaningful results by accounting for impacts over a period of time about equal to the maximum lifetime of an individual; thus, it provides a measure of risk to an individual. Longer integrating periods or an infinite time integral would require extremely speculative predictions.

For all EDC calculations, no attempt was made to predict changes in environmental characteristics. Population size and distribution were based on estimates for the year 2000. Historical meteorological patterns and conditions were assumed to continue, and food production and consumption patterns were assumed to be static.

Table G-20. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Release of Tritium to Four Mile Creek, Millirem per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	All soft tissues	Effective whole body
ADULT		
Fish Drinking	8.81×10^{-5} 2.09×10^{-3}	7.48×10^{-5} 1.78×10^{-3}
Total	2.18×10^{-3}	1.85×10^{-3}
TEEN		
Fish Drinking	6.72×10^{-5} 1.47×10^{-3}	5.70×10^{-5} 1.25×10^{-3}
Total	1.53×10^{-3}	1.31×10^{-3}
CHILD		
Fish Drinking	2.90×10^{-5} 1.47×10^{-3}	2.47×10^{-5} 1.25×10^{-3}
Total	1.50×10^{-3}	1.27×10^{-3}
INFANT		
Drinking	9.48×10^{-4}	8.06×10^{-4}
Total	9.48×10^{-4}	8.06×10^{-4}

G.5 RADIATION-INDUCED HEALTH EFFECTS

Radiation can affect human health by causing cancer, genetic disorders, and other health problems. The Committee on the Biological Effects of Ionizing Radiation (BEIR) of the National Academy of Sciences has published a detailed review of available data on radiation-induced health effects (BEIR, 1980). This report (BEIR III) uses a variety of methods and data to quantify the health impacts of low levels of radiation. Its estimates of health risk associated with radiation exposure have been used to quantify the possible changes in radiation-induced health effects that might be caused by operation of the cooling water systems. These potential health effects are discussed in Chapter 4.

The International Commission on Radiological Protection provides risk estimates for radiation exposure in ICRP Publication 26 (ICRP, 1977). These risk estimates for cancer mortality are generally consistent with BEIR III.

Table G-21. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Remobilization of Radiocesium from Indian Grave/Pen Branch Stream Bed, Millirem per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	Gonads	Breast	R. Marrow	Lung	Thyroid	Bone Surface	SI Wall	ULI Wall	LLI Wall	Effective whole body
ADULT										
Fish	6.82×10^{-2}	5.85×10^{-2}	6.33×10^{-2}	6.33×10^{-2}	6.33×10^{-2}	6.33×10^{-2}	6.82×10^{-2}	6.82×10^{-2}	6.82×10^{-2}	6.82×10^{-2}
Drinking	4.88×10^{-4}	4.18×10^{-4}	4.53×10^{-4}	4.53×10^{-4}	4.53×10^{-4}	4.53×10^{-4}	4.88×10^{-4}	4.88×10^{-4}	4.88×10^{-4}	4.88×10^{-4}
Shoreline	1.26×10^{-4}	1.14×10^{-4}	9.56×10^{-5}	9.42×10^{-5}	1.18×10^{-4}	1.07×10^{-4}	7.84×10^{-5}	9.22×10^{-5}	8.53×10^{-5}	1.06×10^{-4}
Total	6.88×10^{-2}	5.90×10^{-2}	6.38×10^{-2}	6.38×10^{-2}	6.39×10^{-2}	6.39×10^{-2}	6.88×10^{-2}	6.88×10^{-2}	6.88×10^{-2}	6.88×10^{-2}
TEEN										
Fish	5.20×10^{-2}	4.45×10^{-2}	4.82×10^{-2}	4.82×10^{-2}	4.82×10^{-2}	4.82×10^{-2}	5.20×10^{-2}	5.20×10^{-2}	5.20×10^{-2}	5.20×10^{-2}
Drinking	3.41×10^{-4}	2.92×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.41×10^{-4}	3.41×10^{-4}	3.41×10^{-4}	3.41×10^{-4}
Shoreline	4.22×10^{-4}	3.83×10^{-4}	3.20×10^{-4}	3.16×10^{-4}	3.96×10^{-4}	3.57×10^{-4}	2.63×10^{-4}	3.09×10^{-4}	2.86×10^{-4}	3.55×10^{-4}
Total	5.28×10^{-2}	4.52×10^{-2}	4.88×10^{-2}	4.88×10^{-2}	4.89×10^{-2}	4.89×10^{-2}	5.26×10^{-2}	5.26×10^{-2}	5.26×10^{-2}	5.27×10^{-2}
CHILD										
Fish	2.25×10^{-2}	1.93×10^{-2}	2.09×10^{-2}	2.09×10^{-2}	2.09×10^{-2}	2.09×10^{-2}	2.25×10^{-2}	2.25×10^{-2}	2.25×10^{-2}	2.25×10^{-2}
Drinking	3.41×10^{-4}	2.92×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.17×10^{-4}	3.41×10^{-4}	3.41×10^{-4}	3.41×10^{-4}	3.41×10^{-4}
Shoreline	8.81×10^{-5}	7.99×10^{-5}	6.69×10^{-5}	6.60×10^{-5}	8.28×10^{-5}	7.46×10^{-5}	5.49×10^{-5}	6.45×10^{-5}	5.97×10^{-5}	7.42×10^{-5}
Total	2.29×10^{-2}	1.97×10^{-2}	2.13×10^{-2}	2.13×10^{-2}	2.13×10^{-2}	2.13×10^{-2}	2.29×10^{-2}	2.29×10^{-2}	2.29×10^{-2}	2.29×10^{-2}
INFANT										
Drinking	2.21×10^{-4}	1.89×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.21×10^{-4}	2.21×10^{-4}	2.21×10^{-4}	2.21×10^{-4}
Total	2.21×10^{-4}	1.89×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.05×10^{-4}	2.21×10^{-4}	2.21×10^{-4}	2.21×10^{-4}	2.21×10^{-4}

G-29

BC-22

Table G-22. Decrease in Annual Dose to Maximally Exposed Individual from Reduced Remobilization of Radiocesium from Four Mile Creek Stream Bed, Millirem per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	Gonads	Breast	R. Marrow	Lung	Thyroid	Bone Surface	SI Wall	ULI Wall	LLI Wall	Effective whole body
ADULT										
Fish	1.19×10^{-1}	1.02×10^{-1}	1.11×10^{-1}	1.11×10^{-1}	1.11×10^{-1}	1.11×10^{-1}	1.19×10^{-1}	1.19×10^{-1}	1.19×10^{-1}	1.19×10^{-1}
Drinking	8.54×10^{-4}	7.32×10^{-4}	7.93×10^{-4}	7.93×10^{-4}	7.93×10^{-4}	7.93×10^{-4}	8.54×10^{-4}	8.54×10^{-4}	8.54×10^{-4}	8.54×10^{-4}
Shoreline	2.20×10^{-4}	2.00×10^{-4}	1.67×10^{-4}	1.65×10^{-4}	2.07×10^{-4}	1.87×10^{-4}	1.37×10^{-4}	1.61×10^{-4}	1.49×10^{-4}	1.85×10^{-4}
Total	1.20×10^{-1}	1.03×10^{-1}	1.12×10^{-1}	1.12×10^{-1}	1.12×10^{-1}	1.12×10^{-1}	1.20×10^{-1}	1.20×10^{-1}	1.20×10^{-1}	1.20×10^{-1}
TEEN										
Fish	9.09×10^{-2}	7.79×10^{-2}	8.44×10^{-2}	8.44×10^{-2}	8.44×10^{-2}	8.44×10^{-2}	9.09×10^{-2}	9.09×10^{-2}	9.09×10^{-2}	9.09×10^{-2}
Drinking	5.97×10^{-4}	5.12×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.97×10^{-4}	5.97×10^{-4}	5.97×10^{-4}	5.97×10^{-4}
Shoreline	7.38×10^{-4}	6.69×10^{-4}	5.61×10^{-4}	5.53×10^{-4}	6.94×10^{-4}	6.25×10^{-4}	4.60×10^{-4}	5.40×10^{-4}	5.00×10^{-4}	6.21×10^{-4}
Total	9.22×10^{-2}	7.91×10^{-2}	8.55×10^{-2}	8.55×10^{-2}	8.56×10^{-2}	8.56×10^{-2}	9.20×10^{-2}	9.20×10^{-2}	9.20×10^{-2}	9.21×10^{-2}
CHILD										
Fish	3.93×10^{-2}	3.37×10^{-2}	3.65×10^{-2}	3.65×10^{-2}	3.65×10^{-2}	3.65×10^{-2}	3.93×10^{-2}	3.93×10^{-2}	3.93×10^{-2}	3.93×10^{-2}
Drinking	5.97×10^{-4}	5.12×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.54×10^{-4}	5.97×10^{-4}	5.97×10^{-4}	5.97×10^{-4}	5.97×10^{-4}
Shoreline	1.54×10^{-4}	1.40×10^{-4}	1.17×10^{-4}	1.15×10^{-4}	1.45×10^{-4}	1.31×10^{-4}	9.61×10^{-5}	1.13×10^{-4}	1.04×10^{-4}	1.30×10^{-4}
Total	4.01×10^{-2}	3.44×10^{-2}	3.72×10^{-2}	3.72×10^{-2}	3.72×10^{-2}	3.72×10^{-2}	4.00×10^{-2}	4.00×10^{-2}	4.00×10^{-2}	4.00×10^{-2}
INFANT										
Drinking	3.86×10^{-4}	3.31×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.86×10^{-4}	3.86×10^{-4}	3.86×10^{-4}	3.86×10^{-4}
Total	3.86×10^{-4}	3.31×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.59×10^{-4}	3.86×10^{-4}	3.86×10^{-4}	3.86×10^{-4}	3.86×10^{-4}

BC-22

Table G-23. Decrease in Collective Dose from Reduced Tritium Release to Indian Grave/Pen Branch, Person-Rem per Year (Once-Through Cooling Tower for K-Reactor)

Pathway	All soft tissues	Effective whole body
Drinking water		
Beaufort-Jasper	1.33×10^{-2}	1.13×10^{-2}
Port Wentworth	2.51×10^{-2}	2.13×10^{-2}
Total	3.84×10^{-2}	3.26×10^{-2}
Sport fish		
	2.72×10^{-5}	2.31×10^{-5}
Commercial fish	1.73×10^{-6}	1.47×10^{-6}
Shellfish	5.32×10^{-8}	4.52×10^{-8}
Total	2.90×10^{-5}	2.46×10^{-5}
Grand total	3.84×10^{-2}	3.26×10^{-2}

Table G-24. Decrease in Collective Dose from Reduced Tritium Release to Four Mile Creek, Person-Rem per Year (Once-Through Cooling Tower for C-Reactor)

Pathway	All soft tissues	Effective whole body
Drinking water		
Beaufort-Jasper	1.33×10^{-2}	1.13×10^{-2}
Port Wentworth	2.51×10^{-2}	2.13×10^{-2}
Total	3.84×10^{-2}	3.26×10^{-2}
Sport fish		
	2.72×10^{-5}	2.31×10^{-5}
Commercial fish	1.73×10^{-6}	1.47×10^{-6}
Shellfish	5.32×10^{-8}	4.52×10^{-8}
Total	2.90×10^{-5}	2.46×10^{-5}
Grand total	3.84×10^{-2}	3.26×10^{-2}

Table G-25. Decrease in Collective Dose from Reduced Tritium Release to Indian Grave/Pen Branch, Person-Rem per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	All soft tissues	Effective whole body
Drinking water		
Beaufort-Jasper	1.13×10^{-1}	9.58×10^{-2}
Port Wentworth	2.14×10^{-1}	1.82×10^{-1}
Total	3.27×10^{-1}	2.78×10^{-1}
Sport fish		
Commercial fish	2.30×10^{-4}	1.96×10^{-4}
Shellfish	1.47×10^{-5}	1.25×10^{-5}
Total	2.45×10^{-4}	2.09×10^{-4}
Grand total	3.27×10^{-1}	2.78×10^{-1}

Table G-26. Decrease in Collective Dose from Reduced Tritium Release to Four Mile Creek, Person-Rem per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	All soft tissues	Effective whole body
Drinking water		
Beaufort-Jasper	1.13×10^{-1}	9.58×10^{-2}
Port Wentworth	2.14×10^{-1}	1.82×10^{-1}
Total	3.27×10^{-1}	2.78×10^{-1}
Sport fish		
Commercial fish	2.30×10^{-4}	1.96×10^{-4}
Shellfish	1.47×10^{-5}	1.25×10^{-5}
Total	2.45×10^{-4}	2.09×10^{-4}
Grand total	3.27×10^{-1}	2.78×10^{-1}

The total cancer risk for all organs reported in ICRP-26 is 1.25×10^{-4} per rem, compared to 1.20×10^{-4} reported in BEIR III. However, the genetic risk estimate reported in ICRP-26 is about three times lower than that of BEIR III. BEIR III risk estimates were used in this analysis because (1) BEIR III is a more recent and comprehensive evaluation of radiation-induced health effects and (2) BEIR III results in higher estimates of total risk.

Table G-27. Decrease in Collective Dose from Reduced Remobilization of Radiocesium from Indian Grave/Pen Branch Stream Bed, Person-Rem Per Year (Recirculating Cooling Towers for K-Reactor)

Pathway	Gonads	Breast	R. Marrow	Lung	Thyroid	Bone Surface	SI Wall	ULI Wall	LLI Wall	Effective whole body
Drinking water										
Beaufort-Jasper	1.05×10^{-2}	8.99×10^{-3}	9.74×10^{-3}	9.74×10^{-3}	9.74×10^{-3}	9.74×10^{-3}	1.05×10^{-2}	1.05×10^{-2}	1.05×10^{-2}	1.05×10^{-2}
Port Wentworth	3.81×10^{-2}	3.27×10^{-2}	3.54×10^{-2}	3.54×10^{-2}	3.54×10^{-2}	3.54×10^{-2}	3.81×10^{-2}	3.81×10^{-2}	3.81×10^{-2}	3.81×10^{-2}
Total	4.86×10^{-2}	4.17×10^{-2}	4.51×10^{-2}	4.51×10^{-2}	4.51×10^{-2}	4.51×10^{-2}	4.86×10^{-2}	4.86×10^{-2}	4.86×10^{-2}	4.86×10^{-2}
Sport fish										
Commercial fish	1.79×10^{-1}	1.53×10^{-1}	1.66×10^{-1}	1.66×10^{-1}	1.66×10^{-1}	1.66×10^{-1}	1.79×10^{-1}	1.79×10^{-1}	1.79×10^{-1}	1.79×10^{-1}
Shellfish	1.14×10^{-2}	9.74×10^{-3}	1.06×10^{-2}	1.06×10^{-2}	1.06×10^{-2}	1.06×10^{-2}	1.14×10^{-2}	1.14×10^{-2}	1.14×10^{-2}	1.14×10^{-2}
Shoreline	2.83×10^{-6}	2.42×10^{-6}	2.63×10^{-6}	2.63×10^{-6}	2.63×10^{-6}	2.63×10^{-6}	2.83×10^{-6}	2.83×10^{-6}	2.83×10^{-6}	2.83×10^{-6}
Total	1.26×10^{-3}	1.14×10^{-3}	9.56×10^{-4}	9.42×10^{-4}	1.18×10^{-3}	1.07×10^{-3}	7.84×10^{-4}	9.22×10^{-4}	8.53×10^{-4}	1.06×10^{-3}
Grand Total	2.40×10^{-1}	2.06×10^{-1}	2.23×10^{-1}	2.23×10^{-1}	2.23×10^{-1}	2.23×10^{-1}	2.40×10^{-1}	2.40×10^{-1}	2.40×10^{-1}	2.40×10^{-1}

Table G-28. Decrease in Collective Dose from Reduced Remobilization of Radiocesium from Four Mile Creek Stream Bed,
Person-Rem Per Year (Recirculating Cooling Towers for C-Reactor)

Pathway	Gonads	Breast	R. Marrow	Lung	Thyroid	Bone Surface	SI Wall	ULI Wall	LLI Wall	Effective whole body
Drinking water										
Beaufort-Jasper	1.83×10^{-2}	1.57×10^{-2}	1.70×10^{-2}	1.70×10^{-2}	1.70×10^{-2}	1.70×10^{-2}	1.83×10^{-2}	1.83×10^{-2}	1.83×10^{-2}	1.83×10^{-2}
Port Wentworth	6.67×10^{-2}	5.71×10^{-2}	6.19×10^{-2}	6.19×10^{-2}	6.19×10^{-2}	6.19×10^{-2}	6.67×10^{-2}	6.67×10^{-2}	6.67×10^{-2}	6.67×10^{-2}
Total	8.50×10^{-2}	7.28×10^{-2}	7.89×10^{-2}	7.89×10^{-2}	7.89×10^{-2}	7.89×10^{-2}	8.50×10^{-2}	8.50×10^{-2}	8.50×10^{-2}	8.50×10^{-2}
Sport fish										
Commercial fish	3.13×10^{-1}	2.68×10^{-1}	2.91×10^{-1}	2.19×10^{-1}	2.91×10^{-1}	2.91×10^{-1}	3.13×10^{-1}	3.13×10^{-1}	3.13×10^{-1}	3.13×10^{-1}
Shellfish	1.99×10^{-2}	1.71×10^{-2}	1.85×10^{-2}	1.85×10^{-2}	1.85×10^{-2}	1.85×10^{-2}	1.99×10^{-2}	1.99×10^{-2}	1.99×10^{-2}	1.99×10^{-2}
Shoreline	4.95×10^{-6}	4.24×10^{-6}	4.59×10^{-6}	4.59×10^{-6}	4.59×10^{-6}	4.59×10^{-6}	4.95×10^{-6}	4.95×10^{-6}	4.95×10^{-6}	4.95×10^{-6}
Total	3.35×10^{-1}	2.87×10^{-1}	3.11×10^{-1}	3.11×10^{-1}	3.12×10^{-1}	3.11×10^{-1}	3.34×10^{-1}	3.35×10^{-1}	3.34×10^{-1}	3.35×10^{-1}
Grand Total	4.20×10^{-1}	3.60×10^{-1}	3.90×10^{-1}	3.90×10^{-1}	3.90×10^{-1}	3.90×10^{-1}	4.19×10^{-1}	4.20×10^{-1}	4.19×10^{-1}	4.20×10^{-1}

BC-22

Table G-29. Annual Maximum Individual Doses from Atmospheric Releases; Cumulative Impact
Without the Cooling Alternatives, in Year 2000 (Millirem Per Year)

Receptor organ	Facilities					Total from all facilities
	SRP	DWPF	FMF	FPF ^a	Vogtle ^b	
ADULT						
Gonads	5.85×10^{-1}	1.89×10^{-4}	5.41×10^{-7}	1.15×10^{-8}		5.85×10^{-1}
Breast	5.99×10^{-1}	1.68×10^{-4}	2.75×10^{-6}	2.16×10^{-8}	5.59×10^{-1}	5.99×10^{-1}
R. Marrow	1.85×10^{-1}	1.07×10^{-3}	5.93×10^{-5}	2.49×10^{-7}	3.41×10^{-1}	7.45×10^{-1}
Lungs	6.47×10^{-1}	4.33×10^{-4}	4.53×10^{-2}	1.90×10^{-4}	9.96×10^{-1}	1.03
Thyroid	3.77	6.54×10^{-3}	1.77×10^{-7}	9.69×10^{-9}		4.77
Bone Surface	3.59×10^{-1}	2.77×10^{-3}	9.19×10^{-4}	3.77×10^{-6}		3.63×10^{-1}
ST Wall	4.88×10^{-1}	7.59×10^{-5}	8.53×10^{-8}	6.37×10^{-9}		4.88×10^{-1}
SI Wall	4.85×10^{-1}	1.53×10^{-4}	5.58×10^{-8}	5.50×10^{-9}		4.85×10^{-1}
ULI Wall	6.20×10^{-1}	2.72×10^{-4}	3.27×10^{-4}	7.24×10^{-5}		6.21×10^{-1}
LLI Wall	5.62×10^{-1}	4.74×10^{-4}	1.00×10^{-3}	2.06×10^{-4}	3.45×10^{-1}	9.09×10^{-1}
Kidneys	4.37×10^{-1}	7.97×10^{-5}	3.88×10^{-4}	1.59×10^{-6}	4.51×10^{-1}	8.88×10^{-1}
Liver	4.86×10^{-1}	2.29×10^{-4}	7.14×10^{-8}	6.38×10^{-9}	6.44×10^{-1}	1.13
Pancreas	5.30×10^{-1}	6.71×10^{-5}	8.50×10^{-8}	5.48×10^{-9}		5.30×10^{-1}
Spleen	5.44×10^{-1}	7.48×10^{-5}	8.39×10^{-8}	6.39×10^{-9}		5.44×10^{-1}
Thymus	4.44×10^{-1}	8.37×10^{-5}	9.04×10^{-8}	7.43×10^{-9}		4.44×10^{-1}
Uterus	4.32×10^{-1}	6.81×10^{-5}	5.38×10^{-8}	5.58×10^{-9}		4.32×10^{-1}
Adrenals	4.39×10^{-1}	7.95×10^{-5}	1.28×10^{-7}	7.17×10^{-9}		4.39×10^{-1}
Blad. Wall	5.30×10^{-1}	7.70×10^{-5}	7.06×10^{-8}	6.39×10^{-9}		5.30×10^{-1}
Skin	6.23×10^{-1}	1.19×10^{-4}	4.87×10^{-6}	3.05×10^{-8}	4.01×10^{-1}	1.02
Remainder	5.17×10^{-2}	8.98×10^{-5}	0.00	0.00		5.18×10^{-2}
E.W.B.D.	6.38×10^{-1}	7.00×10^{-4}	5.58×10^{-3}	3.98×10^{-5}	5.39×10^{-1}	1.18
TEEN						
Gonads	6.28×10^{-1}	2.04×10^{-4}	5.41×10^{-7}	1.15×10^{-8}		6.28×10^{-1}
Breast	6.42×10^{-1}	1.81×10^{-4}	2.75×10^{-6}	2.16×10^{-8}		6.42×10^{-1}
R. Marrow	1.89×10^{-1}	1.21×10^{-3}	6.82×10^{-5}	2.85×10^{-7}	7.49×10^{-1}	9.39×10^{-1}
Lungs	6.90×10^{-1}	4.47×10^{-4}	4.53×10^{-2}	1.90×10^{-4}	3.65×10^{-1}	1.10
Thyroid	4.31	7.54×10^{-3}	1.77×10^{-7}	9.69×10^{-9}	1.28	5.60

Table G-29. Annual Maximum Individual Doses from Atmospheric Releases; Cumulative Impact
Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

Receptor organ	Facilities					Total from all facilities
	SRP	DWPF	FMF	FPP ^a	Vogtle ^b	
TEEN (continued)						
Bone Surface	3.68×10^{-1}	3.07×10^{-3}	1.06×10^{-3}	4.34×10^{-6}		3.72×10^{-1}
ST Wall	5.32×10^{-1}	7.69×10^{-5}	8.53×10^{-8}	6.37×10^{-9}		5.32×10^{-1}
SI Wall	5.28×10^{-1}	1.68×10^{-4}	5.58×10^{-8}	5.50×10^{-9}		5.28×10^{-1}
ULI Wall	6.55×10^{-1}	2.67×10^{-4}	3.77×10^{-4}	5.04×10^{-5}		6.56×10^{-1}
LLI Wall	5.83×10^{-1}	4.33×10^{-4}	1.15×10^{-3}	1.43×10^{-4}	3.61×10^{-1}	9.46×10^{-1}
Kidneys	4.77×10^{-1}	8.07×10^{-5}	4.47×10^{-4}	1.83×10^{-6}	5.26×10^{-1}	1.00
Liver	5.28×10^{-1}	2.31×10^{-4}	7.14×10^{-8}	6.38×10^{-9}	8.47×10^{-1}	1.38
Pancreas	5.71×10^{-1}	6.81×10^{-5}	8.50×10^{-8}	5.48×10^{-9}		5.71×10^{-1}
Spleen	5.85×10^{-1}	7.58×10^{-5}	8.39×10^{-8}	6.39×10^{-9}		5.85×10^{-1}
Thymus	4.85×10^{-1}	8.47×10^{-5}	9.04×10^{-8}	7.43×10^{-9}		4.85×10^{-1}
Uterus	4.73×10^{-1}	6.91×10^{-5}	5.38×10^{-8}	5.58×10^{-9}		4.73×10^{-1}
Adrenals	4.79×10^{-1}	8.05×10^{-5}	1.28×10^{-7}	7.17×10^{-9}		4.79×10^{-1}
Blad. Wall	5.70×10^{-1}	7.80×10^{-5}	7.06×10^{-8}	6.39×10^{-9}		5.70×10^{-1}
Skin	6.63×10^{-1}	1.20×10^{-4}	4.87×10^{-6}	3.05×10^{-9}	4.15×10^{-1}	1.08
Remainder	5.50×10^{-2}	1.05×10^{-4}	0.00	0.00		5.51×10^{-2}
E.W.B.D.	6.87×10^{-1}	7.64×10^{-4}	5.60×10^{-3}	3.47×10^{-5}	5.26×10^{-1}	1.22
CHILD						
Gonads	4.85×10^{-1}	1.83×10^{-4}	5.41×10^{-7}	1.15×10^{-8}		4.85×10^{-1}
Breast	5.00×10^{-1}	1.62×10^{-4}	2.75×10^{-6}	2.16×10^{-8}		5.00×10^{-1}
R. Marrow	1.71×10^{-1}	9.77×10^{-4}	5.54×10^{-5}	2.34×10^{-7}	1.81	1.98
Lungs	5.19×10^{-1}	2.79×10^{-4}	2.10×10^{-2}	8.77×10^{-5}	4.24×10^{-1}	9.64×10^{-1}
Thyroid	3.47	6.13×10^{-3}	1.77×10^{-7}	9.69×10^{-9}	2.16	5.64
Bone Surface	2.73×10^{-1}	2.27×10^{-3}	8.60×10^{-4}	3.52×10^{-6}		2.76×10^{-1}
ST Wall	3.89×10^{-1}	7.37×10^{-5}	8.53×10^{-8}	6.37×10^{-9}		3.89×10^{-1}
SI Wall	3.86×10^{-1}	1.46×10^{-4}	5.58×10^{-8}	5.50×10^{-9}		3.86×10^{-1}
ULI Wall	5.07×10^{-1}	2.22×10^{-4}	3.05×10^{-4}	3.47×10^{-5}		5.08×10^{-1}

Table G-29. Annual Maximum Individual Doses from Atmospheric Releases; Cumulative Impact
Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

Receptor organ	Facilities					Total from all facilities
	SRP	DWPF	FMF	FPF ^a	Vogtle ^b	
CHILD (continued)						
LLI Wall	4.23×10^{-1}	3.43×10^{-4}	9.36×10^{-4}	9.87×10^{-5}	4.15×10^{-1}	8.39×10^{-1}
Kidneys	3.46×10^{-1}	7.75×10^{-5}	3.63×10^{-4}	1.49×10^{-6}	6.91×10^{-1}	1.04
Liver	3.78×10^{-1}	1.47×10^{-4}	7.14×10^{-8}	6.38×10^{-9}	1.25	1.63
Pancreas	4.40×10^{-1}	6.49×10^{-5}	8.50×10^{-8}	5.48×10^{-9}		4.40×10^{-1}
Spleen	4.54×10^{-1}	7.26×10^{-5}	8.39×10^{-8}	6.39×10^{-9}		4.54×10^{-1}
Thymus	3.54×10^{-1}	8.15×10^{-5}	9.04×10^{-8}	7.43×10^{-9}		3.54×10^{-1}
Uterus	3.42×10^{-1}	6.59×10^{-5}	5.38×10^{-8}	5.58×10^{-9}		3.42×10^{-1}
Adrenals	3.48×10^{-1}	7.73×10^{-5}	1.28×10^{-7}	7.17×10^{-9}		3.48×10^{-1}
Bladder Wall	4.39×10^{-1}	7.48×10^{-5}	7.06×10^{-8}	6.39×10^{-9}		4.39×10^{-1}
Skin	5.32×10^{-1}	1.17×10^{-4}	4.87×10^{-6}	3.05×10^{-8}	4.71×10^{-1}	1.00
Remainder	4.38×10^{-2}	8.49×10^{-5}	0.00	0.00		4.39×10^{-2}
E.W.B.D.	5.36×10^{-1}	6.23×10^{-4}	2.64×10^{-3}	1.88×10^{-5}	5.37×10^{-1}	1.08
INFANT						
Gonads	2.11×10^{-1}	1.19×10^{-4}	5.41×10^{-7}	1.15×10^{-8}		2.11×10^{-1}
Breast	2.26×10^{-1}	1.07×10^{-4}	2.75×10^{-6}	2.16×10^{-8}		2.26×10^{-1}
R. Marrow	1.32×10^{-1}	1.23×10^{-4}	9.28×10^{-7}	1.02×10^{-8}	1.06	1.19
Lungs	2.30×10^{-1}	1.41×10^{-4}	7.93×10^{-3}	3.32×10^{-5}	4.18×10^{-1}	6.56×10^{-1}
Thyroid	6.86×10^{-1}	1.05×10^{-3}	1.77×10^{-7}	9.69×10^{-9}	4.11	4.80
Bone Surface	1.65×10^{-1}	2.68×10^{-4}	1.35×10^{-5}	6.53×10^{-8}		1.65×10^{-1}
ST Wall	1.16×10^{-1}	6.79×10^{-5}	8.53×10^{-8}	6.37×10^{-9}		1.16×10^{-1}
SI Wall	1.12×10^{-1}	8.27×10^{-5}	5.58×10^{-8}	5.50×10^{-9}		1.12×10^{-1}
ULI Wall	2.20×10^{-1}	9.34×10^{-5}	4.81×10^{-6}	2.64×10^{-8}		2.20×10^{-1}
LLI Wall	1.12×10^{-1}	8.93×10^{-5}	1.46×10^{-5}	6.68×10^{-8}	3.38×10^{-1}	4.50×10^{-1}
Kidneys	1.04×10^{-1}	7.17×10^{-5}	5.70×10^{-6}	2.96×10^{-8}	5.49×10^{-1}	6.53×10^{-1}
Liver	1.20×10^{-1}	9.43×10^{-5}	7.14×10^{-8}	6.38×10^{-9}	1.09	1.21

Table G-29. Annual Maximum Individual Doses from Atmospheric Releases; Cumulative Impact
Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

Receptor organ	Facilities					Total from all facilities
	SRP	DWPF	FMF	FPP ^a	Vogtle ^b	
INFANT (continued)						
Pancreas	1.97×10^{-1}	5.91×10^{-5}	8.50×10^{-8}	5.48×10^{-9}		1.97×10^{-1}
Spleen	2.11×10^{-1}	6.68×10^{-5}	8.39×10^{-8}	6.39×10^{-9}		2.11×10^{-1}
Thymus	1.11×10^{-1}	7.57×10^{-5}	9.04×10^{-8}	7.43×10^{-9}		1.11×10^{-1}
Uterus	9.91×10^{-2}	6.01×10^{-5}	5.38×10^{-8}	5.58×10^{-9}		9.92×10^{-2}
Adrenals	1.06×10^{-1}	7.15×10^{-5}	1.28×10^{-7}	7.17×10^{-9}		1.06×10^{-1}
Bladder Wall	1.97×10^{-1}	6.90×10^{-5}	7.06×10^{-8}	6.39×10^{-9}		1.97×10^{-1}
Skin	2.90×10^{-1}	1.11×10^{-4}	4.87×10^{-6}	3.05×10^{-8}	3.97×10^{-1}	6.87×10^{-1}
Remainder	1.28×10^{-2}	2.31×10^{-5}	0.00	0.00		1.28×10^{-2}
E.W.B.D.	2.22×10^{-1}	2.27×10^{-4}	9.55×10^{-4}	4.01×10^{-6}	3.92×10^{-1}	6.15×10^{-1}

a. There are no radioactive liquid releases during normal FPF operations.

b. Doses from Georgia Power Company, 1985.

Table G-30. Annual Maximum Individual Doses from Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year)

Receptor organ	Facilities					Total from all facilities
	SRP	DWPF	FMF	FPP ^a	Vogtle ^b	
ADULT						
Gonads	1.13	4.38×10^{-3}	3.88×10^{-7}			1.13
Breast	9.65×10^{-1}	4.38×10^{-3}	1.97×10^{-6}			9.69×10^{-1}
R. Marrow	9.26×10^{-1}	4.99×10^{-6}	2.76×10^{-4}			1.54
Lungs	1.01	4.38×10^{-3}	9.54×10^{-8}			1.32
Thyroid	1.01	5.55×10^{-3}	1.27×10^{-7}			1.70
Bone Surface	9.86×10^{-1}	7.37×10^{-6}	4.29×10^{-3}			9.90×10^{-1}
ST Wall	2.19×10^{-1}	4.73×10^{-3}	6.12×10^{-8}			2.24×10^{-1}
SI Wall	1.16	4.37×10^{-3}	4.01×10^{-8}			1.16
ULI Wall	4.84×10^{-1}	4.42×10^{-3}	1.52×10^{-3}			4.90×10^{-1}
LLI Wall	1.18	4.49×10^{-3}	4.67×10^{-3}			1.51
Kidneys	2.20×10^{-1}	4.40×10^{-3}	1.81×10^{-3}			7.75×10^{-1}
Liver	2.19×10^{-1}	4.39×10^{-3}	5.13×10^{-8}			1.49
Pancreas	2.19×10^{-1}	4.38×10^{-3}	6.10×10^{-8}			2.23×10^{-1}
Spleen	2.19×10^{-1}	4.38×10^{-3}	6.02×10^{-8}			2.23×10^{-1}
Thymus	2.19×10^{-1}	4.37×10^{-3}	6.49×10^{-8}			2.23×10^{-1}
Uterus	2.19×10^{-1}	4.37×10^{-3}	3.86×10^{-8}			2.23×10^{-1}
Adrenals	2.19×10^{-1}	4.37×10^{-3}	9.15×10^{-8}			2.23×10^{-1}
Blad. Wall	2.19×10^{-1}	4.37×10^{-3}	5.06×10^{-8}			2.23×10^{-1}
Skin	2.20×10^{-1}	4.37×10^{-3}	3.50×10^{-6}			2.27×10^{-1}
Remainder	9.87×10^{-1}	3.15×10^{-9}				9.87×10^{-1}
E.W.B.D.	1.08	3.67×10^{-3}	6.49×10^{-4}			2.07
TEEN						
Gonads	8.47×10^{-1}	3.07×10^{-3}	1.30×10^{-6}			8.50×10^{-1}
Breast	7.25×10^{-1}	3.07×10^{-3}	6.60×10^{-6}			7.28×10^{-1}
R. Marrow	7.05×10^{-1}	3.72×10^{-6}	1.95×10^{-4}			1.36
Lungs	7.61×10^{-1}	3.07×10^{-3}	3.20×10^{-7}			1.05
Thyroid	7.62×10^{-1}	3.92×10^{-3}	4.24×10^{-7}			1.35
Bone Surface	7.47×10^{-1}	5.48×10^{-6}	3.02×10^{-3}			7.50×10^{-1}

Table G-30. Annual Maximum Individual Doses from Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

Receptor organ	Facilities					Total from all facilities
	SRP	DWPF	FMF	FPF ^a	Vogtle ^b	
TEEN (continued)						
ST Wall	1.56×10^{-1}	3.32×10^{-3}	2.05×10^{-7}			1.59×10^{-1}
SI Wall	8.69×10^{-1}	3.07×10^{-3}	1.34×10^{-7}			8.72×10^{-1}
ULI Wall	3.57×10^{-1}	3.10×10^{-3}	1.07×10^{-3}			3.61×10^{-1}
LLI Wall	8.88×10^{-1}	3.15×10^{-3}	3.29×10^{-3}			
Kidneys	1.56×10^{-1}	3.09×10^{-3}	1.28×10^{-3}			5.14×10^{-1}
Liver	1.56×10^{-1}	3.08×10^{-3}	1.72×10^{-7}			1.25
Pancreas	1.55×10^{-1}	3.07×10^{-3}	2.04×10^{-7}			
Spleen	1.56×10^{-1}	3.07×10^{-3}	2.02×10^{-7}			
Thymus	1.56×10^{-1}	3.07×10^{-3}	2.17×10^{-7}			
Uterus	1.55×10^{-1}	3.07×10^{-3}	1.29×10^{-7}			
Adrenals	1.56×10^{-1}	3.07×10^{-3}	3.07×10^{-7}			
Bladder Wall	1.56×10^{-1}	3.07×10^{-3}	1.70×10^{-7}			
Skin	1.58×10^{-1}	3.07×10^{-3}	1.17×10^{-5}			
Remainder	7.51×10^{-1}	2.40×10^{-9}				
E.W.B.D.	8.15×10^{-1}	2.58×10^{-3}	4.58×10^{-4}			
CHILD						
Gonads	4.51×10^{-1}	2.99×10^{-3}	2.72×10^{-7}			4.54×10^{-1}
Breast	3.98×10^{-1}	2.99×10^{-3}	1.38×10^{-6}			4.01×10^{-1}
R. Marrow	3.23×10^{-1}	2.21×10^{-6}	1.84×10^{-4}			
Lungs	4.14×10^{-1}	2.99×10^{-3}	6.68×10^{-8}			3.56×10^{-1}
Thyroid	4.14×10^{-1}	3.64×10^{-3}	8.87×10^{-8}			1.14
Bone Surface	3.61×10^{-1}	3.67×10^{-6}	2.86×10^{-3}			
ST Wall	1.50×10^{-1}	3.18×10^{-3}	4.29×10^{-8}			
SI Wall	4.61×10^{-1}	2.99×10^{-3}	2.80×10^{-8}			
ULI Wall	2.40×10^{-1}	3.01×10^{-3}	1.02×10^{-3}			
LLI Wall	4.76×10^{-1}	3.05×10^{-3}	3.12×10^{-3}			
					2.84×10^{-1}	7.66×10^{-1}

Table G-30. Annual Maximum Individual Doses from Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

Receptor organ	Facilities					Total from all facilities
	SRP	DWPF	FMF	FPP ^a	Vogtle ^b	
CHILD (continued)						
Kidneys	1.50×10^{-1}	3.00×10^{-3}	1.21×10^{-3}		5.67×10^{-1}	7.21×10^{-1}
Liver	1.50×10^{-1}	3.00×10^{-3}	3.59×10^{-8}		1.23	1.38
Pancreas	1.50×10^{-1}	2.99×10^{-3}	4.27×10^{-8}			1.53×10^{-1}
Spleen	1.50×10^{-1}	2.99×10^{-3}	4.21×10^{-8}			1.53×10^{-1}
Thymus	1.50×10^{-1}	2.99×10^{-3}	4.54×10^{-8}			1.53×10^{-1}
Uterus	1.50×10^{-1}	2.99×10^{-3}	2.71×10^{-8}			1.53×10^{-1}
Adrenals	1.50×10^{-1}	2.99×10^{-3}	6.41×10^{-8}			1.53×10^{-1}
Bladder Wall	1.50×10^{-1}	2.99×10^{-3}	3.55×10^{-8}			1.53×10^{-1}
Skin	1.50×10^{-1}	2.99×10^{-3}	2.45×10^{-6}		3.58×10^{-3}	1.57×10^{-1}
Remainder	3.28×10^{-1}	1.05×10^{-9}				3.28×10^{-1}
E.W.B.D.	4.25×10^{-1}	2.50×10^{-3}	4.33×10^{-4}		4.32×10^{-1}	8.60×10^{-1}
INFANT						
Gonads	9.76×10^{-2}	1.90×10^{-3}				9.95×10^{-2}
Breast	9.71×10^{-2}	1.90×10^{-3}				4.90×10^{-2}
R. Marrow	2.13×10^{-2}	6.89×10^{-7}	1.14×10^{-4}		3.39×10^{-2}	5.53×10^{-2}
Lungs	9.72×10^{-2}	1.90×10^{-3}			2.39×10^{-1}	3.38×10^{-2}
Thyroid	9.72×10^{-2}	2.21×10^{-3}			1.42	1.52
Bone Surface	4.45×10^{-2}	1.51×10^{-6}	1.77×10^{-3}			4.63×10^{-2}
ST Wall	9.47×10^{-2}	1.99×10^{-3}				9.67×10^{-2}
SI Wall	9.77×10^{-2}	1.90×10^{-3}				9.96×10^{-2}
ULI Wall	9.84×10^{-2}	1.91×10^{-3}	6.31×10^{-4}			1.01×10^{-1}
LLI Wall	1.06×10^{-1}	1.93×10^{-3}	1.93×10^{-3}		2.39×10^{-1}	3.49×10^{-1}
Kidneys	9.49×10^{-2}	1.90×10^{-3}	7.49×10^{-4}		2.51×10^{-1}	3.49×10^{-1}
Liver	9.48×10^{-2}	1.90×10^{-3}			2.82×10^{-1}	3.79×10^{-1}
Pancreas,	9.47×10^{-2}	1.90×10^{-3}				9.66×10^{-2}
Spleen	9.47×10^{-2}	1.90×10^{-3}				9.66×10^{-2}

G-41

|BC-22

Table G-30. Annual Maximum Individual Doses from Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year) (continued)

Receptor organ	Facilities				Total from all facilities
	SRP	DWPF	FMF	FPP ^a	
INFANT (continued)					
Thymus	9.47×10^{-2}	1.90×10^{-3}			9.66×10^{-2}
Uterus	9.47×10^{-2}	1.90×10^{-3}			9.66×10^{-2}
Adrenals	9.47×10^{-2}	1.90×10^{-3}			9.66×10^{-2}
Bladder Wall	9.47×10^{-2}	1.90×10^{-3}			9.66×10^{-2}
Skin	9.47×10^{-2}	1.90×10^{-3}			9.66×10^{-2}
Remainder	3.19×10^{-3}	1.01×10^{-1}			3.19×10^{-3}
E.W.B.D.	8.51×10^{-2}	1.58×10^{-3}	2.68×10^{-4}	2.42×10^{-1}	3.29×10^{-1}

a. There are no radioactive liquid releases during normal FPF operations.

b. Doses from Georgia Power Company, 1985.

Table G-31. Annual Maximum Individual Doses from Combined Atmospheric and Liquid Releases; Cumulative Impact Without the Cooling Alternatives, in Year 2000 (Millirem Per Year)

Receptor organ	Total from all facilities			
	Adult	Teen	Child	Infant
Gonads	1.72	1.48	9.39×10^{-1}	3.11×10^{-1}
Breast	1.57	1.37	9.01×10^{-1}	3.25×10^{-1}
R. Marrow	2.29	2.30	3.21	1.25
Lungs	2.35	2.15	1.74	9.94×10^{-1}
Thyroid	6.48	6.95	7.19	6.32
Bone Surface	1.35	1.12	6.40×10^{-1}	2.12×10^{-1}
ST Wall	7.12×10^{-1}	6.91×10^{-1}	5.42×10^{-1}	2.13×10^{-1}
SI Wall	1.65	1.40	8.50×10^{-1}	2.12×10^{-1}
ULI Wall	1.11	1.02	7.52×10^{-1}	3.21×10^{-1}
LLI Wall	2.42	2.08	1.61	7.99×10^{-1}
Kidneys	1.66	1.68	1.76	1.00
Liver	2.62	2.78	3.01	1.59
Pancreas	7.53×10^{-1}	7.29×10^{-1}	5.93×10^{-1}	2.94×10^{-1}
Spleen	7.67×10^{-1}	7.44×10^{-1}	6.07×10^{-1}	3.08×10^{-1}
Thymus	6.67×10^{-1}	6.44×10^{-1}	5.07×10^{-1}	2.08×10^{-1}
Uterus	6.55×10^{-1}	6.31×10^{-1}	4.95×10^{-1}	1.96×10^{-1}
Adrenals	6.62×10^{-1}	6.38×10^{-1}	5.01×10^{-1}	2.03×10^{-1}
Bladder Wall	7.53×10^{-1}	7.29×10^{-1}	5.92×10^{-1}	2.94×10^{-1}
Skin	1.25	1.26	1.16	7.84×10^{-1}
Remainder	1.04	8.06×10^{-1}	3.72×10^{-1}	1.60×10^{-2}
E.W.B.D.	3.25	2.64	1.94	9.44×10^{-1}

G-43

Table G-32. Annual Collective Doses from Atmospheric and Liquid Releases; Cumulative Impact
Without the Cooling Alternatives, in Year 2000 (Person-Rem Per Year)

Receptor organ	Facilities					Total from all facilities
	SRP	DWPF	FMF	FPF ^a	Vogtle ^b	
ATMOSPHERIC						
Gonads	4.12×10^1	3.52×10^{-2}	3.77×10^{-4}	7.98×10^{-6}		4.12×10^1
Breast	4.12×10^1	3.22×10^{-2}	1.91×10^{-3}	1.50×10^{-5}		4.12×10^1
R. Marrow	1.04×10^1	8.03×10^{-2}	3.02×10^{-3}	1.68×10^{-5}	3.24×10^{-1}	1.08×10^1
Lungs	4.87×10^1	6.41×10^{-2}	6.14	2.57×10^{-2}	4.82×10^{-1}	5.54×10^1
Thyroid	3.58×10^2	6.64×10^{-1}	1.23×10^{-4}	6.75×10^{-6}	6.12×10^{-1}	3.59×10^2
Bone Surface	3.02×10^1	2.26×10^{-1}	4.63×10^{-2}	1.96×10^{-4}		3.05×10^1
ST Wall	3.67×10^1	2.16×10^{-2}	5.94×10^{-5}	4.43×10^{-6}		3.67×10^1
SI Wall	3.62×10^1	2.34×10^{-2}	3.89×10^{-5}	3.83×10^{-6}		3.62×10^1
ULI Wall	4.25×10^1	3.28×10^{-2}	1.65×10^{-2}	4.15×10^{-3}		4.26×10^1
LLI Wall	4.07×10^1	4.25×10^{-2}	5.03×10^{-2}	1.18×10^{-2}	4.76×10^{-1}	4.13×10^1
Kidneys	3.41×10^1	2.30×10^{-2}	1.95×10^{-2}	8.42×10^{-5}	4.79×10^{-1}	3.46×10^1
Liver	3.91×10^1	4.21×10^{-2}	4.97×10^{-5}	4.44×10^{-6}	4.83×10^{-1}	3.96×10^1
Pancreas	3.77×10^1	1.88×10^{-2}	5.92×10^{-5}	3.81×10^{-6}		3.77×10^1
Spleen	3.86×10^1	2.13×10^{-2}	5.84×10^{-5}	4.45×10^{-6}		3.86×10^1
Thymus	3.42×10^1	2.42×10^{-2}	6.29×10^{-5}	5.17×10^{-6}		3.42×10^1
Uterus	3.34×10^1	1.91×10^{-2}	3.75×10^{-5}	3.89×10^{-6}		3.34×10^1
Adrenals	3.41×10^1	2.28×10^{-2}	8.88×10^{-5}	4.99×10^{-6}		3.41×10^1
Bladder Wall	3.77×10^1	2.20×10^{-2}	4.91×10^{-5}	4.45×10^{-6}		3.77×10^1
Skin	4.27×10^1	3.63×10^{-2}	3.39×10^{-3}	2.13×10^{-5}	7.58×10^{-1}	4.35×10^1
Remainder	2.77	4.22×10^{-3}				2.77
E.W.B.D.	4.78×10^1	9.37×10^{-2}	7.44×10^{-1}	4.07×10^{-3}	4.80×10^{-1}	4.91×10^1
LIQUID						
Gonads	3.52×10^1	6.50×10^{-1}	3.88×10^{-6}			3.59×10^1
Breast	3.47×10^1	6.50×10^{-1}	1.97×10^{-5}			3.53×10^1
R. Marrow	9.02	2.47×10^{-4}	3.93×10^{-2}			9.06
Lungs	3.48×10^1	6.50×10^{-1}	9.54×10^{-7}			3.55×10^1
Thyroid	3.48×10^1	7.60×10^{-1}	1.27×10^{-6}			3.56×10^1
Bone Surface	1.71×10^1	5.28×10^{-4}	6.10×10^{-1}			1.77×10^1

Table G-32. Annual Collective Doses from Atmospheric and Liquid Releases; Cumulative Impact
Without the Cooling Alternatives, in Year 2000 (Person-Rem Per Year) (continued)

Receptor organ	Facilities				Total from all facilities
	SRP	DWPF	FMF	FPP ^a	
LIQUID (continued)					
ST Wall	3.24×10^1	6.83×10^{-1}	6.12×10^{-7}		3.31×10^1
SI Wall	3.53×10^1	6.50×10^{-1}	4.01×10^{-7}		3.60×10^1
ULI Wall	3.42×10^1	6.56×10^{-1}	2.16×10^{-1}		3.51×10^1
LLI Wall	3.81×10^1	6.62×10^{-1}	6.63×10^{-1}		3.95×10^1
Kidneys	3.26×10^1	6.52×10^{-1}	2.57×10^{-1}		3.35×10^1
Liver	3.24×10^1	6.52×10^{-1}	5.13×10^{-7}		3.31×10^1
Pancreas	3.24×10^1	6.52×10^{-1}	6.10×10^{-7}		3.31×10^1
Spleen	3.24×10^1	6.52×10^{-1}	6.02×10^{-7}		3.31×10^1
Thymus	3.24×10^1	6.50×10^{-1}	6.49×10^{-7}		3.31×10^1
Uterus	3.24×10^1	6.50×10^{-1}	3.86×10^{-7}		3.31×10^1
Adrenals	3.24×10^1	6.50×10^{-1}	9.15×10^{-7}		3.31×10^1
Bladder Wall	3.24×10^1	6.50×10^{-1}	5.06×10^{-7}		3.31×10^1
Skin	3.24×10^1	6.50×10^{-1}	3.05×10^{-5}		3.31×10^1
Remainder	2.94	9.41×10^{-9}			2.94
E.W.B.D.	3.09×10^1	5.42×10^{-1}	9.21×10^{-2}		3.15×10^1
COMBINED ATMOSPHERIC AND LIQUID					
Gonads					7.71×10^1
Breast					7.66×10^1
R. Marrow					1.99×10^1
Lungs					9.09×10^1
Thyroid					3.95×10^2
Bone Surface					4.81×10^1
ST Wall					6.98×10^1
SI Wall					7.22×10^1
ULI Wall					7.77×10^1
LLI Wall					8.07×10^1

Table G-32. Annual Collective Doses from Atmospheric and Liquid Releases; Cumulative Impact
Without the Cooling Alternatives, in Year 2000 (Person-Rem Per Year) (continued)

Receptor organ	Facilities				Total from all facilities
	SRP	DWPF	FMF	FPF ^a	
COMBINED ATMOSPHERIC AND LIQUID (continued)					
Kidneys					6.82×10^1
Liver					7.27×10^1
Pancreas					7.08×10^1
Spleen					7.17×10^1
Thymus					6.73×10^1
Uterus					6.65×10^1
Adrenals					6.72×10^1
Bladder Wall					7.08×10^1
Skin					7.66×10^1
Remainder					5.72
E.W.B.D.					8.07×10^1

a. There are no radioactive liquid releases during normal FPF operations.

b. Doses from Georgia Power Company, 1985; liquid dose is "negligible."

Table G-33. Effective Whole-Body Doses to the Maximally Exposed Individual from Cumulative Atmospheric Releases, Comparison of Cooling Alternatives (Millirem per Year)

Cooling alternative	Adult	Teen	Child	Infant
Present cooling system	1.18	1.22	1.08	6.15×10^{-1}
Once-through cooling towers (K- and C-Reactors)	1.18	1.22	1.08	6.15×10^{-1}
Recirculating cooling towers (K- and C-Reactors)	1.18	1.22	1.08	6.15×10^{-1}

Table G-34. Effective Whole-Body Doses to the Maximally Exposed Individual from Cumulative Liquid Releases to Savannah River, Comparison of Cooling Alternatives (Millirem per Year)

Cooling alternative	Adult	Teen	Child	Infant
Present cooling system	2.07	1.42	8.60×10^{-1}	3.29×10^{-1}
Once-through cooling towers (K- and C-Reactors)	2.07	1.42	8.60×10^{-1}	3.29×10^{-1}
Recirculating cooling towers (K- and C-Reactors)	1.88	1.27	7.95×10^{-1}	3.27×10^{-1}

Table G-35. Effective Whole-Body Doses to the Maximally Exposed Individual from Cumulative Atmospheric and Liquid Releases, Comparison of Cooling Alternatives (Millirem per Year)

Cooling alternative	Adult	Teen	Child	Infant
Present cooling system	3.25	2.64	1.94	9.44×10^{-1}
Once-through cooling towers (K- and C-Reactors)	3.25	2.64	1.94	9.44×10^{-1}
Recirculating cooling towers (K- and C-Reactors)	3.06	2.49	1.88	9.42×10^{-1}

The BEIR III report identifies three categories of radiation-induced human health effects: (1) cancer, (2) genetic disorders, and (3) somatic effects other than cancer. The committee believes cancer induction is the most important effect of low-dose radiation. In this context, "low dose" refers to

Table G-36. Comparison of 80-Kilometer Collective Dose from Increased Release of Tritium to the Atmosphere with Present Cooling Systems: Once-Through Cooling Towers for K- and C-Reactors and Recirculating Cooling Towers for K- and C-Reactors (Person-Rem per Year)

Cooling alternative	Effective whole body
Present cooling systems (no action)	4.91×10^1
Once-through cooling towers	4.91×10^1
Recirculating cooling towers	4.92×10^1

Table G-37. Comparison of Collective Dose from Reduced Liquid Releases to Savannah River with Present Cooling Systems: Once-Through Cooling Towers for K- and C-Reactors and Recirculating Cooling Towers for K- and C-Reactors (Person-Rem per Year)

Cooling alternative	Effective whole body
Present cooling systems (no action)	3.15×10^1
Once-through cooling towers	3.14×10^1
Recirculating cooling towers	3.03×10^1

Table G-38. Comparison of Collective Dose from Increased Atmospheric Releases and Reduced Liquid Releases with Present Cooling Systems: Once-Through Cooling Towers for K- and C-Reactors and Recirculating Cooling Towers for K- and C-Reactors (Person-Rem per Year)

Cooling alternative	Effective whole body
Present cooling systems (no action)	8.07×10^1
Once-through cooling towers	8.05×10^1
Recirculating cooling towers	7.96×10^1

doses as high as a few rads per person per year. Natural background radiation ranges from 0.1 to 0.2 rad per person per year. Genetic effects of low-level radiation have been well documented and are addressed in detail in the BEIR III report. Somatic effects other than cancer include cataract induction and fertility impairment. The BEIR III report concludes that low-dose exposure of

human populations does not increase the risk of somatic effects other than cancer and developmental changes in unborn children. The report also indicates that developmental changes in unborn children are probably not caused by radiation at or below natural background levels. For these reasons, only cancer and genetic disorders are considered in this analysis.

Cancer data from the Japanese survivors of atomic bomb blasts are used in most of the analyses in the BEIR III report. A major question addressed by the BEIR III report is how to extrapolate the cancer risks observed at the relatively high dose rates down to the lower dose rates caused by most nuclear facilities. The BEIR III report adopted a parametric family of functions to complete this extrapolation. The linear model represents an upper limit or maximum risk; the linear-quadratic model, an intermediate or probable risk; and the quadratic model, a low-limit or minimum risk. These functions have been suggested by the report for low linear energy transfer (LET) radiation. This type radiation includes gamma and X-radiation and electrons (beta particles). High-LET radiation includes alpha particles encountered in the decay of radionuclides in the natural uranium decay chain. The BEIR III report states that for High-LET radiation, "the linear hypothesis is less likely to lead to over estimates of risk and may, in fact, lead to underestimates." The linear model would, therefore, represent the best estimate for probable risk from this type radiation.

One radiation-induced cancer characteristic is that it takes a long time to develop, known as the latent period. Leukemia has a characteristically short latent period (less than 25 years), while other cancers can have latent periods for as long as the life span of an individual. Because only about 35 years of cancer data have been collected on the survivors of atomic bomb blasts, the data do not account for all the cancers that might develop because of the bombs' radiation. Two projection models have been developed to account for these future cancer deaths: (1) the absolute risk projection model, which assumes that the cancer rate (risk per year) observed since the atomic bomb blasts will continue throughout the life spans of those exposed; and (2) the relative-risk model, which assumes the excess radiation-induced risk is proportional to the natural incidence of cancer with age. The relative-risk model results in cancer-risk estimates greater than those predicted by the absolute model. However, the BEIR III report states that the absolute model is generally more applicable to most forms of cancer. The cancer-risk estimates used represent an average of those calculated using the absolute- and relative-risk models.

Only low-LET radiation is associated with the changes of radioactivity released to the environment resulting from the implementation of the alternative cooling water systems. For existing operations, the contribution of high-LET radiation has been found to be much less than that from low-LET radiation.

Health-effects estimators for low-LET radiation were derived for use in estimating health effects based on an evaluation of the data presented in the BEIR III report. The resulting health-effects estimators used in this document are summarized in Table G-39. They total 120 fatalities per million person-rem. The health-effects estimate for genetic effects used in this document is 257 genetic effects per million person-rem of radiation, received by the gonads.

These health-effects estimators are the best estimate of risk based on present data. The estimators could vary widely, depending on the models used. The low-LET estimators could range from near 0 to as high as 400 per million person-rem. For genetic effects, the risk estimator could range from 60 to 1100 per million person-rem.

Table G-39. Health Effects Estimators Used in the Evaluation of Radiation Health Effects

Organ/cancer	Cancer fatalities per million person-rem
	Low-LET radiation ^{a, b}
Leukemia and bone cancer ^c	20
Lung	28
Liver	6.5
Kidney and bladder ^c	3.2
Intestinal tract ^c	5.3
Thyroid	6.9
Breast	9.8
Pancreas	7.9
Stomach	11
Other	<u>19</u>
Total	120

- a. LET = linear energy transfer.
- b. The arithmetic average of the absolute and relative model values has been used. In addition, the linear-quadratic model has been assumed.
- c. For multiple organs, the health effects estimators are multiplied by the organ that produces the highest collective organ dose.

REFERENCES

- BEIR (Committee on Biological Effects of Ionizing Radiation, National Academy of Sciences), 1980. The Effects on Population of Exposure to Low Levels of Ionizing Radiation, Division of Medical Sciences, Assembly of Life Sciences, National Research Council, National Academy of Sciences, Washington, D. C.
- DOE (U.S. Department of Energy), 1982a. Final Environmental Impact Statement, Defense Waste Processing Facility, Savannah River Plant, Aiken, South Carolina, DOE/EIS-0082, Savannah River Operations Office, Aiken, South Carolina.
- DOE (U.S. Department of Energy), 1982b. Environmental Assessment, Naval Reactor Fuels Materials Facility, DOE/EA-0170, Savannah River Operations Office, Aiken, South Carolina.
- DOE (U.S. Department of Energy), 1984a. Final Environmental Impact Statement, L-Reactor Operation, Savannah River Plant, Aiken, South Carolina, DOE/EIS0108, Savannah River Operations Office, Aiken, South Carolina.
- DOE (U.S. Department of Energy), 1984b. Thermal Mitigation Study: Compliance with the Federal and South Carolina Water Quality Standards, Savannah River Plant, Aiken, South Carolina, DOE/SR-5003, Savannah River Operations Office, Aiken, South Carolina.
- Du Pont (E. I. du Pont de Nemours and Company), 1981. Environmental Information Document, Defense Waste Processing Facility, DPST-80-249 (2 volumes), Savannah River Laboratory, Aiken, South Carolina.
- Du Pont (E. I. du Pont de Nemours and Company), 1982. Environmental Information Document, L-Reactor Reactivation, DPST-81-241, Savannah River Laboratory, Aiken, South Carolina.
- Du Pont (E. I. du Pont de Nemours and Company), 1983. Environmental Monitoring in the Vicinity of the Savannah River Plant--Annual Report for 1982, DPSPU-83-30-1, Savannah River Laboratory, Aiken, South Carolina.
- Eckerman, K. F., F. J. Congel, A. K. Roecklein, and W. J. Pasciak, 1980. User's Guide to GASPAR Code, NUREG-0597, U.S. Nuclear Regulatory Commission, Washington, D.C.
- EPA (U.S. Environmental Protection Agency), 1974. Environmental Radiation Dose Commitment: An Application to the Nuclear Power Industry, EPA-520/4-73-002, Washington, D.C.
- Georgia Power Company, 1985. Vogtle Electric Generating Plant, Unit 1 and Unit 2, Applicant's Environmental Report, Operating License Stage, through Amendment 6. | TE
- ICRP (International Commission on Radiological Protection), 1977. Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, Pergamon Press, New York.

ICRP (International Commission on Radiological Protection), 1979. Limits for Intakes of Radionuclides by Workers, ICRP Publication 30, Pergamon Press, New York.

NRC (U.S. Nuclear Regulatory Commission), 1977. Calculation of Annual Doses to Man from Routine Releases of Reactor Effluent for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, Regulatory Guide 1.109, Revision 1, Washington, D.C.

Sagendorf, J. F., and J. L. Goll, 1976. XOQDOQ--Program for the Meteorological Evaluation of Routine Effluents Released at Nuclear Power Stations, NUREG-0324, U.S. Nuclear Regulatory Commission, Washington, D.C.

Simpson, D. B., and B. L. McGill, 1980. Users Manual for LADTAP-II -- A Computer Program for Calculating Radiation Exposure to Man from Routine Release of Nuclear Reactor Liquid Effluents, NUREG/CR-1276, ORNL/NUREG/TDMC-1, Oak Ridge National Laboratory, Oak Ridge, Tennessee.